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TECHNICAL REPORT 84-5

ASPHALT CEMENT MONITOR PROGRAM - SUMMER 1983

APRIL, 1984

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TECHNICAL REPORT 84-5

ASPHALT CEMENT MONITOR PROGRAM
SUMMER 1983

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April 1984

MATERIALS BUREAU
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NEW YORK STATE DEPARTMENT OF TRANSPORTATION
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Preface

Each year the Materials Bureau conducts a monitor testing program in cooperation with various suppliers of asphalt cement. Samples are obtained by Bureau personnel and split for testing by both the supplier and the Bureau in accordance with standard AASHTO test procedures. This report summarizes the results of the 1983 program.

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TABLE OF CONTENTS

I.	Introduction	Page 1
II.	Sample Information	Page 2
III.	Tests Performed	Page 3
IV.	Test Data and Sample Identification Forms	Page 3
V.	New York State Department of Transportation Specification for Asphalt Cement	Page 11
VI.	Summary of Test Results	Page 19
VII.	Test Results	Page 20
VIII.	Statistical Analysis of Test Results	Page 32
IX.	Graphs and Charts of Related Material Information	
	A. Comparison TFOT Data	Page 45
	B. Asphaltene Dispersion Data	Page 61

I. Introduction

During July and August, 1983, personnel from the Materials Bureau Chemical Laboratory Section obtained twenty-one samples from fourteen suppliers of asphalt cement. These samples represented many of the sources which had supplied material to the Department during the 1983 construction season including Normal, Canadian, Mid-Continent, Bos Can, Mexican and Venezuelan crude sources.

At the time of sampling, the twenty-one samples were split into two parts. One part was given to the asphalt supplier while the other was returned to the Bureau's Laboratory. All tests were conducted in accordance with the applicable AASHTO test procedure.

Two standard test report forms and one sample identification form were provided by the Bureau for recording sample information and all test results. Each supplier submitted the test results to the Bureau for review and incorporation into this report.

II. Sample Information

A. The distribution of the samples by grade was as follows:

Grade	Number of Samples
Flux	3
AC-5	2
AC-15	3
AC-20	8
85/100	5

B. The supplier, location, crude source and lot numbers are tabulated below.

Flux

Supplier	Location	Lot	Crude Source
Chevron	Perth Amboy	-	Bos Can - Maya
Marathon	Tonawanda	13	Mid-Continent
United Refining	Warren, PA	-	Canadian & Mid Continent

AC-5

Supplier	Location	Lot	Crude Source
B.P. Petro Canada	Oakville, Ont.	51/58	Canadian
United Refining	Warren, PA	6	Mid-Continent

AC-15

Supplier	Location	Lot	Crude Source
B.P. Petro Canada	Oakville, Ont.	107/108	Canadian
Marathon	Tonawanda	15	Mid-Continent
United Refining	Warren, PA	11	Canadian

AC-20

Supplier	Location	Lot	Crude Source
Arco	Philadelphia	31	Normal
Chevron	Perth Amboy	16	Bos Can
Cibro	Albany	21	Bos Can
Exxon	Linden	10	Normal
Monoco	Pittsford, NY	2	Bos Can
Parco	Stamford, CT	24	Normal
Petro Canada	Montreal, Que.	1	Mex. and Venez.
West Bank	Perth Amboy	5	Bos Can

85/100

Suppler	Location	Lot	Crude Source
B. P. Petro Canada	Oakville, Ont.	107/108	Canadian
Esso Canada	Montreal, Que.	1	Can. and Mex.
Gulf Canada	Montreal, Que.	2	Mexican
Petro Canada	Montreal, Que.	7	Mex. and Venez.
Shell Canada	Montreal, Que.	-	Eastern and Canadian

III. Test Performed

A. Tests required by Department of Transportation Specification: (all tests not required on all items of asphalt cement)

1. Viscosity @ 140°F, Absolute, (AASHTO T202)
2. Viscosity @ 275°F, Kinematic, (AASHTO T201)
3. Penetration @ 77°F, (AASHTO T49)
4. Ductility @ 39.2°F, (AASHTO T51)
5. Flash Point, Cleveland Open Cup, (AASHTO T48)
6. Solubility in Trichloroethylene, (AASHTO T44)
7. % Loss on Thin Film Oven Test Residue, (AASHTO T179)
8. Penetration @ 77°F on Thin Film Oven Test Residue (AASHTO T49)
9. Penetration @ 77°F Ratio (% of Original) between the Thin Film Oven Test Residue and the Penetration @ 77°F on the original sample
10. Viscosity @ 140°, Absolute on Thin Film Oven Test Residue (AASHTO T202)
11. Ductility @ 77°F on Thin Film Oven Test Residue (AASHTO T51)

B. Additional tests not required by Department of Transportation Specifications:

1. Penetration @ 39.2°F (AASHTO T49)
2. Penetration Ratio: 39.2°F/77°F
3. Ductility @ 77°F, (AASHTO T51)
4. Specific Gravity @ 77°F (AASHTO T228)
5. Softening Point, Ethylene Glycol (AASHTO T53)
6. Viscosity @ 275°F, Kinematic, on Thin Film Oven Test Residue (AASHTO T201)
7. Ductility @ 60°F on Thin Film Oven Test Residue (AASHTO T51)
8. Viscosity @ 140°F, Absolute, Ratio, between viscosity @ 140°F, Absolute on Thin Film Oven Test Residue Sample and the original sample.
9. A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes.
10. Chemical Analysis of asphalt cement.

C. A Penetration Viscosity Number (PVN) and a Penetration Index Number (PIN) has been computed for each asphalt cement sample.

IV. Test Data and Sample Identification Forms

On the following pages are the Standard Test Report and Sample Identification Forms used for this project.

PRIMARY SOURCE	LOCATION
CRUDE SOURCE	SAMPLED AT
SAMPLED BY	DATE SAMPLED
ITEM NO.	GRADE TYPE
LOT NO,	DATE OF CERTIFICATION

REMARKS:

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1983 ASPHALT MONITOR PROGRAM

TEST NO.

PRIMARY SOURCE	LOCATION

LOT NO.	ITEM NO.	GRADE TYPE

CRUDE SOURCE	AASHTO	RESULTS
1. Viscosity Ratio @ 140 F		
a.) Viscosity of Original Sample,(poises)	T 202	
b.) Viscosity After T.F.O.T.,(poises)	T 202	
2. Viscosity @ 275 F, Centistokes	T 201	
3. Penetration @ 77 F, 100g., 5 sec.	T 49	
4. Penetration @ 39.2 F, 200g., 60 sec.	T 49	
5. Penetration Ratio (39.2°F/77°F) 100		
6. Ductility @ 39.2 F, 1 cm/min., cm.	T 51	
7. Ductility @ 77 F, 5cm/min., cm.	T 51	
8. Flash Point C.O.C., F	T 48	
9. Solubility in Trichloroethylene	T 44	
10. Loss on Heating T.F.O.T.,Percent, 325F @ 5 Hrs	T 179	
11. Specific Gravity @ 77 F	T 228	
12. Ductility @ 60 F, T.F.O.T., 5cm/min., cm.	T 51	
13. Ductility @ 77 F, T.F.O.T., 5cm/min., cm.	T 51	
14. Penetration @ 77 F, T.F.O.T., 100g., 5 sec.	T 49	
a.) Percent of Original		
15. Viscosity @275 F After T.F.O.T. (cst)	T 201	
16. Penetration Viscosity Number, PVN		
17. Softening Point, Ethylene Glycol,°F	T 53	
18. Penetration Index Number, PIN		

NEW YORK STATE

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1983 ASPHALT MONITOR PROGRAM

		TEST NO.
PRIMARY SOURCE	LOCATION	
LOT NO.	ITEM NO.	GRADE TYPE
CRUDE SOURCE		

ASPHALT COMPOSITION ANALYSIS

ASPHALTENES, %	
SATURATES, %	
NAPHTHENE AROMATICS, %	
POLAR AROMATICS, %	

A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes

SETTLEMENT TIME, MINUTES	

V. NEW YORK STATE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR ASPHALT CEMENT

TABLE 702-1

ASPHALT CEMENTS FOR PAVING

MATERIAL DESIGNATION	702-0100		702-0200		702-0300		702-0400		702-0500	
VISCOSITY GRADE	AC-2.5		AC -5		AC-10		AC-15		AC-20	
Test Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity 140F (60 C), P	200	300	400	600	800	1200	1200	1800	1600	2400
Viscosity 275F(135 C), cSt	125		175		250		275		300	
Penetration 77F (25C),100g, 5s	200	325	120	200	70	120	60	100	60	100
Flash Point COC, F(C)	325(163)		350(177)		425(219)		435(225)		450(232)	
Solubility in Trichloroethylene,%	99.0		99.0		99.0		99.0		99.0	
Tests on Residue from Thin Film Oven Test										
Viscosity, 140 F(60C), P		1250		2500		5000		7500		10,000
Ductility, 77 F(25C) 5 cm/min., cm	100		100		75		60		50	
TYPICAL USES (intended only as a general information guide)	Recycle Mix		Hot plant mix very cold climate. Recycle Mix.		Hot plant mix cold climate. Recycle Mix.		Hot plant mix moderate climate.		Hot plant mix moderate climate. Sheet mixes. Open graded surface course mixes.	

TABLE 702-2

MISCELLANEOUS ASPHALT CEMENTS

MATERIAL DESIGNATION	702-0600	
GRADE	85-100	
TEST REQUIREMENTS	Min	Max
Penetration,77F(25C), 100g, 5s	85	100
Viscosity,275F(135C), cSt	280	
Flash Point, COC, F	450	
Solubility in trichloroethylene,%	99.5	
Ductility, 39.2F(4C), 1cm/min., cm	6	
Tests on residue from Thin-film Oven Test (AASHTO T179)		
Loss on Heating, 325F, 5h, %		.85
Penetration, % original	47	
Ductility, 77F(25C), 5cm/min., cm	75	
Typical Uses	Hot plant mix moderate climate	

SPECIFICATION
CHEVRON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	600	800
Viscosity, 275F(135C), cst	200	-
Penetration,77F(25C), 100g., 5 sec.	140	190
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	3200
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
MARATHON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	400	600
Viscosity, 275F(135C), cst	175	-
Penetration,77F(25C), 100g., 5 sec.	175	225
Flash Point, C.O.C., F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
UNITED REFINING
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	300	500
Viscosity, 275F(135C), cst	125	-
Penetration, 77F(25C), 100g., 5 sec.	150	200
Flash Point, C.O.C, F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

VI. Summary of Test Results

Test results for all twenty-one asphalt cement samples met New York State Department of Transportation Specification requirements. The following exceptions are noted below:

A. Exxon, Linden, AC-20, Lot 10, Normal Crude
penetration at 77°F, 58
Specification Requirement 60 to 100
meets Substantial Compliance Limits

B. United Refining, Warren, PA, AC-5, Lot 6, Mid-Continent Crude
penetration at 77°F 94
Specification Requirement 120 to 200
does not meet Specification Requirement or Substantial Compliance Limits

viscosity at 140°F, Absolute 805 poises
Specification Requirement 400 to 600
does not meet Specification Requirement or Substantial Compliance Limits

C. Shell Canada, Montreal, Que., 85/100, Lot -, Eastern and Canadian Crude
penetration at 77°F 83
Specification Requirement 85 to 100
meets Substantial Compliance Limits

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediately to the left.

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot		RATION .2°F	Comparative Results	Penetration Ratio 39.2°/77°F	Comparative Results
FLUX	Chevron, Perth Amboy	-	9	*	36	*
FLUX	Marathon, Tonawanda	13	9	62	30	30
FLUX	United Ref., Warren	-		*	27	*
		$\bar{X}$	3		31	
		σ	4		4.6	
5	B.P. Petro Can., Oakville	51/58		*	28	*
5	United Ref., Warren	6		*	32	*
		$\bar{X}$			30	
		σ			2.8	
15	B.P. Petro Can., Oakville	107/108		*	31	*
15	Marathon, Tonawanda	15		29	32	31
15	United Ref., Warren	11		19	32	29
		$\bar{X}$		24	32	30
		σ		7.1	0.6	1.4
20	Arco, Philadelphia	31		25	35	38
20	Chevron, Perth Amboy	16		*	38	*
20	Cibro, Albany	21		6	35	7
20	Exxon, Linden	10		*	33	*
20	Monoco, Pittsford	2		*	35	*
20	Parco, Stamford	24		*	32	*
20	Petro Can., Montreal	1		27	40	37
20	West Bank, Perth Amboy	5		*	37	*
		$\bar{X}$		19	36	27
		σ		11.6	2.6	17.6
35/100	B.P. Petro Can., Oakville	107/108		*	31	*
35/100	Esso Can., Montreal	1		43	37	47
35/100	Gulf Can., Montreal	2		35	37	36
35/100	Petro Can., Montreal	7		32	34	35
35/100	Shell Can., Montreal	-		*	34	*
		$\bar{X}$		37	35	39
		σ		5.7	2.5	6.7

* Results Not Given

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediately to the left.

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot	Crude Source	Absolute Viscosity @140°F	Comparative Results	Kinematic Viscosity @275°F	Comparative Results	Penetration @77°F	Comparative Results	Penetration @39.2°F	Comparative Results	Penetration Ratio 39.2°/77°F	Comparative Results
FLUX	Chevron, Perth Amboy -	Boscan/Maya	735	*	282	*	165	*	59	*	36	*
FLUX	Marathon, Tonawanda 13	Mid.-Cont.	445	460	202	200.8	196	206	59	62	30	30
FLUX	United Ref., Warren -	Can./Mid-Cont.	374	*	165	*	150	*	41	*	27	*
	$\bar{X}$		518		216		170		53		31	
	σ		191.3		59.8		23.5		10.4		4.6	
5	B.P. Petro Can., Oakville 51/58	Canadian	581	586	231	230	151	153	42	*	28	*
5	United Ref., Warren 6	Mid-Cont.	805	*	234	*	94	*	30	*	32	*
	$\bar{X}$		693		233		123		36		30	
	σ		158.4		2.1		40.3		8.5		2.8	
15	B.P. Petro Can., Oakville 107/108	Canadian	1314	1340	340	340	87	85	27	*	31	*
15	Marathon, Tonawanda 15	Mid-Cont.	1379	1491	346	339.4	87	94	28	29	32	31
15	United Ref., Warren 11	Canadian	1615	1640	350	334	62	65	20	19	32	29
	$\bar{X}$		1436	1490	345	338	79	81	25	24	32	30
	σ		158.4	150.0	5.0	3.3	14.4	14.8	4.4	7.1	0.6	1.4
20	Arco, Philadelphia 31	Normal	2231	2242	438	375	65	65	23	25	35	38
20	Chevron, Perth Amboy 16	Boscan	1818	1797	422	423	89	88	34	*	38	*
20	Cibro, Albany 21	Boscan	2310	2292	507	505	88	91	31	6	35	7
20	Exxon, Linden 10	Normal	2057	2054	404	416	58	66	19	*	33	*
20	Monoco, Pittsford 2	Boscan	1822	1830	430	*	84	85	29	*	35	*
20	Parco, Stamford 24	Normal	1905	1915	394	*	62	65	20	*	32	*
20	Petro Can., Montreal 1	Mex./Venz.	1984	2030	396	380	70	74	28	27	40	37
20	West Bank, Perth Amboy 5	Boscan	2322	2252	498	493	85	83	31	*	37	*
	$\bar{X}$		2056	2052	436	432	75	77	27	19	36	27
	σ		208.8	195.4	43.9	55.4	12.7	10.9	5.5	11.6	2.6	17.6
85/100	B.P. Petro Can., Oakville 107/108	Canadian	1312	1340	340	340	87	85	27	*	31	*
85/100	Esso Can., Montreal 1	Can./Mex.	1570	1792	359	345	86	91	32	43	37	47
85/100	Gulf Can., Montreal 2	Mexican	1260	1497	329	329	96	97	35	35	37	36
85/100	Petro Can., Montreal 7	Mex./Venz.	1337	1350	328	319	89	92	30	32	34	35
85/100	Shell Can., Montreal -	Eastern/Can	1353	*	314	*	83	*	28	*	34	*
	$\bar{X}$		1366	1495	334	333	88	91	30	37	35	39
	σ		119.1	210.8	16.7	11.6	4.9	4.9	3.2	5.7	2.5	6.7

* Results Not Given

1983 ASPHALT CEMENT
MONITOR PROGRAM

AC	SUPPLIER-LOCATION-LOT	CR SC	T. ITY F	COMPARATIVE RESULTS	T.F.O.T. VISCOSITY RATIO	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY -	BOS	8	*	4.35	*
FLUX	MARATHON, TONAWANDA 13	MI	7	1008	2.11	2.19
FLUX	UNITED REF., WARREN -	CAN	1	*	2.62	*
	$\bar{X}$		5		3.03	
	σ		.9		1.17	
5	B.P. PETRO CAN., OAKVILLE 51/58	CA	9	1094	1.96	1.87
5	UNITED REF., WARREN 6	MI	0	*	2.78	*
	$\bar{X}$		0		2.37	
	σ		.5		0.58	
15	B.P. PETRO CAN., OAKVILLE 107/108	CA	91	2497	2.05	1.86
15	MARATHON, TONAWANDA 15	MI	91	3618	2.60	2.43
15	UNITED REF., WARREN 11	CA	4	3831	2.80	2.34
	$\bar{X}$		9	3315	2.48	2.21
	σ		5	716.7	0.39	0.31
20	ARCO, PHILADELPHIA 31	N	43	5515	2.62	2.46
20	CHEVRON, PERTH AMBOY 16	B	0	6216	3.11	3.46
20	CIBRO, ALBANY 21	B	0	6926	3.27	3.02
20	EXXON, LINDEN 10	N	8	3034	2.01	1.48
20	MONOCO, PITTSFORD 2	B	08	*	3.52	*
20	PARCO, STAMFORD 24	N	46	*	2.23	*
20	PETRO CAN., MONTREAL 1	ME	43	6284	3.40	3.10
20	WEST BANK, PERTH AMBOY 5	B	56	4171	2.65	1.85
	$\bar{X}$		43	5358	2.85	2.56
	σ		.0	1475.6	0.56	0.77
85/100	B.P. PETRO CAN., OAKVILLE 107/108	CA	61	2497	2.10	1.86
85/100	ESSO CAN., MONTREAL 1	CA	93	4995	3.37	2.79
85/100	GULF CAN., MONTREAL 2	M	55	4782	3.30	3.19
85/100	PETRO CAN., MONTREAL 7	M	73	3880	2.67	2.87
85/100	SHELL CAN., MONTREAL -	EA	06	*	2.59	*
	$\bar{X}$		58	4039	2.81	2.68
	σ		.9	1135.6	0.53	0.57

*RESULTS NOT GIVEN

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier-Location-Lot	Crude Source	T.F.O.T. Loss %	Comparative Results	T.F.O.T. Ductility @60°F	Comparative Results	T.F.O.T. Ductility @77°F	Comparative Results	T.F.O.T. Viscosity @140°F	Comparative Results	T.F.O.T. Viscosity Ratio	Comparative Results
FLUX	Chevron, Perth Amboy –	Boscan/Maya	1.254	*	61.0	*	150.0+	*	3198	*	4.35	*
FLUX	Marathon, Tonawanda 13	Mid-Cont.	0.264	0.270	150.0+	150.0+	150.0+	150.0+	937	1008	2.11	2.19
FLUX	United Ref., Warren –	Can./Mid-Cont.	0.050	*	25.50	*	119.50	*	981	*	2.62	*
	$\bar{X}$		0.523		78.8		139.8		1705		3.03	
	σ		0.642		64.1		17.6		1292.9		1.17	
5	B.P. Petro Can., Oakville 51/58	Canadian	+0.053 gain	+0.060 gain	150.0+	*	150.0+	150.0+	1139	1094	1.96	1.87
5	United Ref., Warren 6	Mid-Cont.	0.100	*	15.75	*	150.0+	*	2240	*	2.78	*
	$\bar{X}$		0.050		82.9		150.0+		1690		2.37	
	σ		0.071		94.9		—		778.5		0.58	
15	B.P. Petro Can., Oakville 107/108	Canadian	+0.073 gain	+0.080 gain	113.0	*	150.0+	150.0+	2691	2497	2.05	1.86
15	Marathon, Tonawanda 15	Mid-Cont.	0.269	0.280	102.50	117.0	150.0+	150.0+	3591	3618	2.60	2.43
15	United Ref., Warren 11	Canadian	+0.068 gain	+0.050 gain	15.25	23.0	150.0+	140.0+	4514	3831	2.80	2.34
	$\bar{X}$		0.090	0.093	76.9	70.0	150.0+		3599	3315	2.48	2.21
	σ		0.155	0.162	53.7	66.5	—		911.5	716.7	0.39	0.31
20	Arco, Philadelphia 31	Normal	0.046	0.030	22.50	33.0	150.0+	100.0	5843	5515	2.62	2.46
20	Chevron, Perth Amboy 16	Boscan	0.181	0.080	33.0	35.0	150.0+	100.0+	5660	6216	3.11	3.46
20	Cibro, Albany 21	Boscan	0.814	0.590	30.75	86.50	150.0+	150.0+	7550	6926	3.27	3.02
20	Exxon, Linden 10	Normal	+0.054 gain	0.000	78.50	*	150.0+	105.0	4138	3034	2.01	1.48
20	Monoco, Pittsford 2	Boscan	0.182	*	29.0	*	150.0+	*	6408	*	3.52	*
20	Parco, Stamford 24	Normal	+0.034 gain	*	39.0	*	150.0+	*	4246	*	2.23	*
20	Petro Can., Montreal 1	Mex./Venz.	0.153	0.190	12.0	10.0	82.50	100.0+	6743	6284	3.40	3.10
20	West Bank, Perth Amboy 5	Boscan	0.370	0.223	94.0	20.0	150.0+	77.0	6156	4171	2.65	1.85
	$\bar{X}$		0.218	0.186	42.3	36.9	141.6		5843	5358	2.85	2.56
	σ		0.270	0.217	28.5	29.5	23.9		1173.0	1475.6	0.56	0.77
85/100	B.P. Petro Can., Oakville 107/108	Canadian	+0.082 gain	+0.080 gain	117.0	*	150.0+	150.0+	2761	2497	2.10	1.86
85/100	Esso Can., Montreal 1	Can./Mex.	0.025	0.012	13.50	150.0+	108.50	150.0+	5293	4995	3.37	2.79
85/100	Gulf Can., Montreal 2	Mexican	0.064	0.060	16.50	18.0	144.50	135.0	4155	4782	3.30	3.19
85/100	Petro Can., Montreal 7	Mex./Venz.	0.031	0.010	34.25	40.0	150.0+	100.0+	3573	3880	2.67	2.87
85/100	Shell Can., Montreal –	East./Can.	+0.006 gain	*	17.50	*	150.0+	*	3506	*	2.59	*
	$\bar{X}$		0.024	0.021	39.8	69.3	140.6		3858	4039	2.81	2.68
	σ		0.026	0.027	43.9	70.7	18.1		942.9	1135.6	0.53	0.57

*Results Not Given

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot	IFIC ITY 7°F	Comparative Results	C.O.C. Flash Point, °F	Comparative Results
FLUX	Chevron, Perth Amboy -	25	*	442	*
FLUX	Marathon, Tonawanda 13	17	1.017	555	570
FLUX	United Ref., Warren -	00	*	600	*
	$\bar{X}$	14		532	
	σ	13		81.4	
5	B.P. Petro Can., Oakville 51/58	17	1.019	578	601
5	United Ref., Warren 6	07	*	580	*
	$\bar{X}$	12		579	
	σ	07		1.4	
15	B.P. Petro Can., Oakville 107/108	2	1.023	610	614
15	Marathon, Tonawanda 15	.6	1.027	557	590
15	United Ref., Warren 11	9	1.022	615	625
	$\bar{X}$	2	1.024	594	610
	σ	04	0.003	32.1	17.9
20	Arco, Philadelphia 31	8	1.027	655	565
20	Chevron, Perth Amboy 16	2	1.029	520	510
20	Cibro, Albany 21	3	1.033	480	460
20	Exxon, Linden 10	5	1.032	665	550+
20	Monoco, Pittsford 2	9	*	531	*
20	Parco, Stamford 24	5	*	642	*
20	Petro Can., Montreal 1	4	1.025	560	590
20	West Bank, Perth Amboy 5	0	1.031	520	510
	$\bar{X}$	8	1.030	572	
	σ	03	0.003	71.8	
85/100	B.P. Petro Can., Oakville 107/108	2	1.023	620	614
85/100	Esso Can., Montreal 1	7	1.028	625	575
85/100	Gulf Can., Montreal 2	7	1.028	590	560
85/100	Petro Can., Montreal 7	2	1.023	575	600+
85/100	Shell Can., Montreal -	0	*	564	*
	$\bar{X}$	4	1.026	595	
	σ	03	0.003	27.0	
	*Results not given				

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	T.F.O.T. VISCOSITY @275°F	COMPARATIVE RESULTS	T.F.O.T. PENETRATION @77°F	COMPARATIVE RESULTS	T.F.O.T. PENETRATION RATIO	COMPARATIVE RESULTS	SPECIFIC GRAVITY @77°F	COMPARATIVE RESULTS	C.O.C. FLASH POINT, °F	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY -	BOSCAN/MAYA	537	*	68	*	41.2	*	1.025	*	442	*
FLUX	MARATHON, TONAWANDA 13	MID-CONT.	275	276	112	117	57.1	56.8	1.017	1.017	555	570
FLUX	UNITED REF., WARREN -	CAN./MID-CONT.	223	*	78	*	52.0	*	1.000	*	600	*
		$\bar{X}$	345		86		50.1		1.014		532	
		σ	168.3		23.1		8.1		0.013		81.4	
5	B.P. PETRO CAN., OAKVILLE 51/58	CANADIAN	302	*	91	98	60.3	64.1	1.017	1.019	578	601
5	UNITED REF., WARREN 6	MID-CONT.	332	*	56	*	59.6	*	1.007	*	580	*
		$\bar{X}$	317		73.5		60.0		1.012		579	
		σ	21.2		24.7		0.5		0.007		1.4	
15	B.P. PETRO CAN., OAKVILLE 107/108	CANADIAN	444	*	52	56.5	59.8	66.5	1.022	1.023	610	614
15	MARATHON, TONAWANDA 15	MID-CONT.	509	499	50	51	57.5	54.3	1.026	1.027	557	590
15	UNITED REF., WARREN 11	CANADIAN	507	490	39	41	62.9	63.1	1.019	1.022	615	625
		$\bar{X}$	487	495	47	50	60.1	61.3	1.022	1.024	594	610
		σ	37.0	6.4	7.0	7.9	2.7	6.3	0.004	0.003	32.1	17.9
20	ARCO, PHILADELPHIA 31	NORMAL	645	539	43	46	66.2	70.8	1.028	1.027	655	565
20	CHEVRON, PERTH AMBOY 16	BOSCAN	690	766	52	49	58.4	55.7	1.032	1.029	520	510
20	CIBRO, ALBANY 21	BOSCAN	897	831	48	54	54.5	59.3	1.033	1.033	480	460
20	EXXON, LINDEN 10	NORMAL	544	476	40	44	69.0	66.7	1.025	1.032	665	550+
20	MONOCO, PITTSFORD 2	BOSCAN	731	*	48	*	57.1	*	1.029	*	531	*
20	PARCO, STAMFORD 24	NORMAL	543	*	42	*	67.7	*	1.025	*	642	*
20	PETRO CAN., MONTREAL 1	MEX./VENZ.	634	665	43	42	61.4	56.8	1.024	1.025	560	590
20	WEST BANK, PERTH AMBOY 5	BOSCAN	765	694	52	56	61.2	67.5	1.030	1.031	520	510
		$\bar{X}$	681	662	46	49	61.9	62.8	1.028	1.030	572	
		σ	118.1	134.3	4.6	5.6	5.3	6.3	0.003	0.003	71.8	
85/100	B.P. PETRO CAN., OAKVILLE 107/108	CANADIAN	452	*	53	56.5	60.9	66.5	1.022	1.023	620	614
85/100	ESSO CAN., MONTREAL 1	CAN./MEX.	566	487	51	57	59.3	62.6	1.027	1.028	625	575
85/100	GULF CAN., MONTREAL 2	MEXICAN	517	496	58	58	60.4	59.8	1.027	1.028	590	560
85/100	PETRO CAN., MONTREAL 7	MEX./VENZ	488	488	53	52	59.6	56.5	1.022	1.023	575	600+
85/100	SHELL CAN., MONTREAL -	EAST./CAN.	443	*	52	*	62.7	*	1.020	*	564	*
		$\bar{X}$	493	490	53	56	60.6	61.4	1.024	1.026	595	
		σ	50.3	4.9	2.7	2.7	1.3	4.2	0.003	0.003	27.0	

*RESULTS NOT GIVEN

MONITOR PROGRAM

AC	SUPPLIER - LOCATION - LOT	CS	°F	COMPARATIVE RESULTS	PVN	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY -	BC	9	*	-0.161	*
FLUX	MARATHON, TONAWANDA 13	MI	5	98.5	-0.513	-0.459
FLUX	UNITED REF., WARREN -	CA	5	*	-1.177	*
	$\bar{X}$		0		-0.617	
	σ		0		0.516	
5	B.P. PETRO CAN., OAKVILLE 51/58	CA	8	*	-0.608	-0.600
5	UNITED REF., WARREN 6	MI	8	*	-1.109	*
	$\bar{X}$		3		-0.859	
	σ		1		0.354	
15	B.P. PETRO CAN., OAKVILLE 107/108	CB		*	-0.625	-0.650
15	MARATHON, TONAWANDA 15	MB		111	-0.599	-0.543
15	UNITED REF., WARREN 11	CA		123	-0.928	-0.949
	$\bar{X}$			117	-0.717	-0.714
	σ			8.5	0.183	0.210
20	ARCO, PHILADELPHIA 31	N		126	-0.563	-0.784
20	CHEVRON, PERTH AMBOY 16	B		*	-0.276	-0.285
20	CIBRO, ALBANY 21	B		105	-0.013	+0.021
20	EXXON, LINDEN 10	N		*	-0.791	-0.621
20	MONOCO, PITTSFORD 2	B		*	-0.313	*
20	PARCO, STAMFORD 24	N		*	-0.761	*
20	PETRO CAN., MONTREAL 1	M		126	-0.631	-0.633
20	WEST BANK, PERTH AMBOY 5	B		*	-0.081	-0.124
	$\bar{X}$			119	-0.429	-0.404
	σ			12.1	0.300	0.322
35/100	B.P. PETRO CAN., OAKVILLE 107/108	CB		*	-0.625	-0.650
35/100	ESSO CAN., MONTREAL 1	CD		116	-0.556	-0.554
35/100	GULF CAN., MONTREAL 2	MB		119	-0.567	-0.556
35/100	PETRO CAN., MONTREAL 7	M		116	-0.655	-0.661
35/100	SHELL CAN., MONTREAL -	ED		*	-0.794	*
	$\bar{X}$			117	-0.639	-0.605
	σ			1.7	0.096	0.058
	* RESULTS NOT GIVEN					

MONITOR PROGRAM

AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	DUCTILITY @39.2°F	COMPARATIVE RESULTS	DUCTILITY @77°F	COMPARATIVE RESULTS	SOLUBILITY %	COMPARATIVE RESULTS	SOFTENING POINT, °F	COMPARATIVE RESULTS	PVN	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY -	BOSCAN/MAYA	121.0	*	150.0+	*	99.98	*	109	*	-0.161	*
FLUX	MARATHON, TONAWANDA 13	MID.-CONT.	150.0+	15.0+	150.0+	140.0	99.97	99.81	105	98.5	-0.513	-0.459
FLUX	UNITED REF., WARREN -	CAN./MID-CONT.	17.50	*	108.25	*	99.90	*	115	*	-1.177	*
	$\bar{X}$		96.2		136.1		99.95		110		-0.617	
	σ		69.7		24.1		0.04		5.0		0.516	
5	B.P. PETRO CAN., OAKVILLE 51/58	CANADIAN	150.0+	15.0+	150.0+	*	99.91	99.90	108	*	-0.608	-0.600
5	UNITED REF., WARREN 6	MID-CONT.	8.75	*	150.0+	*	99.36	*	118	*	-1.109	*
	$\bar{X}$		79.4		150.0+		99.64		113		-0.859	
	σ		99.9		—		0.39		7.1		0.354	
15	B.P. PETRO CAN., OAKVILLE 107/108	CANADIAN	13.75	15.0+	150.0+	*	99.90	99.75	118	*	-0.625	-0.650
15	MARATHON, TONAWANDA 15	MID-CONT.	38.0	15.0+	150.0+	150.0+	99.98	99.84	118	111	-0.599	-0.543
15	UNITED REF., WARREN 11	CANADIAN	7.50	*	150.0+	140.0+	99.54	*	124	123	-0.928	-0.949
	$\bar{X}$		19.8		150.0+		99.81	99.80	120	117	-0.717	-0.714
	σ		16.1		—		0.23	0.06	3.5	8.5	0.183	0.210
20	ARCO, PHILADELPHIA 31	NORMAL	8.25	*	150.0+	130.0	99.96	99.99	125	126	-0.563	-0.784
20	CHEVRON, PERTH AMBOY 16	BOSCAN	22.0	*	150.0+	*	99.97	99.97	121	*	-0.276	-0.285
20	CIBRO, ALBANY 21	BOSCAN	63.0	*	150.0+	150.0+	99.99	99.98	122	105	-0.013	+0.021
20	EXXON, LINDEN 10	NORMAL	8.25	*	150.0+	*	99.95	99.97	124	*	-0.791	-0.621
20	MONOCO, PITTSFORD 2	BOSCAN	18.25	*	150.0+	*	99.98	*	123	*	-0.313	*
20	PARCO, STAMFORD 24	NORMAL	8.75	*	150.0+	*	99.92	*	122	*	-0.761	*
20	PETRO CAN., MONTREAL 1	MEX./VENZ.	8.50	9.0	150.0+	140.0+	99.86	99.89	124	126	-0.631	-0.633
20	WEST BANK, PERTH AMBOY 5	BOSCAN	84.0	*	150.0+	120.0+	99.98	99.90	120	*	-0.081	-0.124
	$\bar{X}$		27.6		150.0+		99.95	99.95	123	119	-0.429	-0.404
	σ		29.3		—		0.04	0.04	1.7	12.1	0.300	0.322
85/100	B.P. PETRO CAN., OAKVILLE 107/108	CANADIAN	15.50	15.0+	150.0+	*	99.90	99.75	118	*	-0.625	-0.650
85/100	ESSO CAN., MONTREAL 1	CAN./MEX.	11.0	9.0	150.0+	150.0+	99.94	99.99	120	116	-0.556	-0.554
85/100	GULF CAN., MONTREAL 2	MEXICAN	13.50	14.0	150.0+	150.0+	99.85	99.80	118	119	-0.567	-0.556
85/100	PETRO CAN., MONTREAL 7	MEX./VENZ.	18.50	25.0+	150.0+	140.0+	99.94	99.92	117	116	-0.655	-0.661
85/100	SHELL CAN., MONTREAL -	EAST./CAN.	10.75	*	150.0+	*	99.66	*	120	*	-0.794	*
	$\bar{X}$		13.9		150.0+		99.86	99.87	119	117	-0.639	-0.605
	σ		3.2		—		0.12	0.11	1.3	1.7	0.096	0.058

* RESULTS NOT GIVEN

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	SUPPLIER - LOCATION - LOT	CAR STATICS
FLUX	CHEVRON, PERTH AMBOY -	Bd. 2
FLUX	MARATHON, TONAWANDA 13	M. 5
FLUX	UNITED REF., WARREN -	Cr. 9
	$\bar{X}$	.2
	σ	3
5	B.P. PETRO CAN., OAKVILLE 51/58	C 3
5	UNITED REF., WARREN 6	M. 9
	$\bar{X}$	6
	σ	8
15	B.P. PETRO CAN., OAKVILLE 107/108	C. 4
15	MARATHON, TONAWANDA 15	M. 1
15	UNITED REF., WARREN 11	2
	$\bar{X}$	6
	σ	5
20	ARCO, PHILADELPHIA 31	.8
20	CHEVRON, PERTH AMBOY 16	.3
20	CIBRO, ALBANY 21	.2
20	EXXON, LINDEN 10	.0
20	MONOCO, PITTSFORD 2	.1
20	PARCO, STAMFORD 24	.6
20	PETRO CAN., MONTREAL 1	M. 9
20	WEST BANK, PERTH AMBOY 5	4
	$\bar{X}$	9
	σ	4
5/100	B.P. PETRO CAN., OAKVILLE 107/108	.3
5/100	ESSO CAN., MONTREAL 1	.9
5/100	GULF CAN., MONTREAL 2	.2
5/100	PETRO CAN., MONTREAL 7	.9
5/100	SHELL CAN., MONTREAL -	E. 0
	$\bar{X}$	5
	σ	5
	*RESULTS NOT GIVEN	

1983 ASPHALT CEMENT MONITOR PROGRAM

AC	Supplier - Location - Lot	Crude Source	PIN	Comparative Results	Settlement Test Minutes	Asphaltenes %	Saturates %	% Naphthene Aromatics	% Polar Aromatics
FLUX	Chevron, Perth Amboy -	Boscan/Maya	+0.245	*	27.8	17.0	9.0	27.5	38.2
FLUX	Marathon, Tonawanda 13	Mid-Cont.	+0.124	-1.346	38.2	11.0	11.5	29.9	42.5
FLUX	United Ref., Warren -	Can./Mid-Cont.	+1.022	*	92.8	11.2	18.0	30.8	33.9
	$\bar{X}$		+0.464		52.9	13.1	12.8	29.4	38.2
	σ		0.487		34.9	3.4	4.6	1.7	4.3
5	B.P. Petro Can., Oakville 51/58	Canadian	-0.330	*	32.1	10.7	14.0	29.1	41.3
5	United Ref., Warren 6	Mid-Cont.	-0.136	*	99.7	14.0	18.4	29.5	35.9
	$\bar{X}$		-0.233		65.9	12.4	16.2	29.3	38.6
	σ		0.137		47.8	2.3	3.1	0.3	3.8
15	B.P. Petro Can., Oakville 107/108	Canadian	-0.370	*	30.7	11.6	10.0	29.6	42.4
15	Marathon, Tonawanda 15	Mid-Cont.	-0.370	-1.334	36.1	13.1	8.8	26.8	45.1
15	United Ref., Warren 11	Canadian	-0.406	-0.424	66.3	12.3	11.6	30.0	40.2
	$\bar{X}$		-0.382	-0.879	44.4	12.3	10.1	28.8	42.6
	σ		0.021	0.643	19.2	0.8	1.4	1.7	2.5
20	Arco, Philadelphia 31	Normal	-0.145	-0.008	38.1	15.8	10.1	29.3	39.8
20	Chevron, Perth Amboy 16	Boscan	+0.167	*	21.7	18.5	14.6	29.9	33.3
20	Cibro, Albany 21	Boscan	+0.284	-2.564	17.3	17.0	7.8	21.6	44.2
20	Exxon, Linden 10	Normal	-0.573	*	33.8	12.5	9.2	29.8	42.0
20	Monoco, Pittsford 2	Boscan	+0.291	*	27.6	17.7	9.9	25.2	40.1
20	Parco, Stamford 24	Normal	-0.687	*	30.0	12.9	10.1	28.5	41.6
20	Petro Can., Montreal 1	Mex./Venz.	-0.086	+0.349	52.7	17.0	11.9	28.5	36.9
20	West Bank, Perth Amboy 5	Boscan	-0.125	*	25.7	16.1	7.8	28.0	41.4
	$\bar{X}$		-0.109	-0.741	30.9	15.9	10.2	27.6	39.9
	σ		0.367	1.589	11.0	2.2	2.2	2.8	3.4
85/100	B.P. Petro Can., Oakville 107/108	Canadian	-0.370	*	26.9	11.2	9.6	29.2	44.3
85/100	Esso Can., Montreal 1	Can./Mex.	-0.090	-0.562	35.3	17.0	11.6	29.5	36.9
85/100	Gulf Can., Montreal 2	Mexican	-0.071	+0.123	38.0	16.8	12.2	27.8	36.2
85/100	Petro Can., Montreal 7	Mex./Venz.	-0.464	-0.529	48.3	15.1	12.0	27.7	38.9
85/100	Shell Can., Montreal -	East./Can.	-0.195	*	93.5	14.3	11.8	32.5	36.0
	$\bar{X}$		-0.238	-0.323	48.4	14.9	11.4	29.3	38.5
	σ		0.173	0.386	26.3	2.4	1.1	1.9	3.5

*Results Not Given

Only one supplier submitted Asphalt Composition Analysis Results to the Materials Bureau.

Petro-Canada, Montreal, Que. Ac-20 and 85/100

Comparison test results are noted as follows:

Asphalt Composition Analysis

	AC-20	
	Materials Bureau	Petro-Canada
%Asphaltenes,	17.0	20.2
%Saturates,	11.9	16.2
% Naphthene Aromatics	28.5	25.8
%Polar Aromatics	36.9	35.3

	85/100	
	Materials Bureau	Petro-Canada
%Asphaltenes,	15.1	13.4
%Saturates,	12.0	14.9
%Naphthene Aromatics,	27.7	24.7
%Polar Aromatics,	38.9	42.1

VIII. Statistical Analysis of Test Results

The mean, range and standard deviation were determined for the number of samples tested in each grade of asphalt cement. For each test, this statistical information has been determined separately for the Materials Bureau results and when applicable, the comparable results submitted by the supplier.

A. Absolute Viscosity @ 140°F (Poises)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	518	693	1436	2056	1366
Range	374 to 735	581 to 805	1314 to 1615	1818 to 2322	1260 to 1570
Stan. Deviation	191.3	158.4	158.4	208.8	119.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	8	4
Mean	-	-	1490	2052	1495
Range	-	-	1340 to 1640	1797 to 2292	1340 to 1792
Stan. Deviation	-	-	150.0	195.4	210.8

B. Kinematic Viscosity @ 275°F (Centistokes)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	216	233	345	436	334
Range	165 to 282	231 to 234	340 to 350	394 to 507	314 to 359
Stan. Deviation	59.8	2.1	5.0	43.9	16.7

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	338	432	333
Range	-	-	334 to 340	375 to 505	319 to 354
Stan. Deviation	-	-	3.3	55.4	11.6

C. Penetration @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	170	123	79	75	88
Range	150 to 196	94 to 151	62 to 87	58 to 89	83 to 96
Stan. Deviation	23.5	40.3	14.4	12.7	4.9

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	8	4
Mean	-	-	81	77	91
Range	-	-	65 to 94	65 to 91	85 to 97
Stan. Deviation	-	-	14.8	10.9	4.9

D. Penetration @ 39.2°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	53	36	25	27	30
Range	41 to 59	30 to 42	20 to 28	19 to 34	27 to 35
Stan. Deviation	10.4	8.5	4.4	5.5	3.2

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	3	3
Mean	-	-	24	19	37
Range	-	-	19 to 29	6 to 27	32 to 43
Stan. Deviation	-	-	7.1	11.6	5.7

E. Penetration Ratio

(Penetration @ 39.2°F ÷ Penetration @ 77°F x 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	31	30	32	36	35
Range	27 to 36	28 to 32	31 to 32	32 to 40	31 to 37
Stan. Deviation	4.6	2.8	0.6	2.6	2.5

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	3	3
Mean	-	-	30	27	39
Range	-	-	29 to 31	7 to 38	35 to 47
Stan. Deviation	-	-	1.4	17.6	6.7

F. Thin Film Oven Test, % Loss

(Samples which showed weight gains were calculated as 0.000% Loss)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	0.523	0.050	0.090	0.218	0.024
Range	0.050 to 1.254	0.000 to 0.100	0.000 to 0.269	0.000 to 0.814	0.000 to 0.064
Stan. Deviation	0.642	0.071	0.155	0.270	0.026

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	0.093	0.186	0.021
Range	-	-	0.000 to 0.280	0.000 to 0.590	0.000 to 0.060
Stan. Deviation	-	-	0.162	0.217	0.027

G. Thin Film Oven Test, Ductility @ 60°F, 5cm/min. (Centimeters)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	78.8	82.9	76.9	42.3	39.8
Range	25.50 to 150.0+	15.75 to 150.0+	15.25 to 113.0	12.0 to 94.0	13.50 to 117.0
Stan. Deviation	64.1	94.9	53.7	28.5	43.9

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	5	3
Mean	-	-	70.0	36.9	69.3
Range	-	-	23.0 to 117.0	10.0 to 86.50	18.0 to 150.0+
Stan. Deviation	-	-	66.5	29.5	70.7

H. Thin Film Oven Test, Ductility @ 77°F, 5cm/min. (Centimeters)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	139.8	150.0+	150.0+	141.6	140.6
Range	119.50 to 150.0+	150.0+	150.0+	82.50 to 150.0+	108.50 to 150.0+
Stan. Deviation	17.6	-	-	23.9	18.1

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	-	-	-
Range	-	-	140.0 t0 150.0+	77.0 to 150.0+	100.0+ to 150.0+
Stan. Deviation	-	-	-	-	-

I. Thin Film Oven Test, Absolute Viscosity @ 140°F (Poises)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	1705	1690	3599	5843	3858
Range	937 to 3198	1139 to 2240	2691 to 4514	4138 to 7550	2761 to 5293
Stan. Deviation	1292.9	778.5	911.5	1173.0	942.9

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	3315	5358	4039
Range	-	-	2497 to 3831	3034 to 6926	2497 to 4995
Stan. Deviation	-	-	716.7	1475.6	1135.6

J. Absolute Viscosity @ 140°F Ratio (After TFOT Viscosity @ 140°F ÷ Original Viscosity @ 140°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	3.03	2.37	2.48	2.85	2.81
Range	2.11 to 4.35	1.96 to 2.78	2.05 to 2.80	2.01 to 3.52	2.10 to 3.37
Stan. Deviation	1.17	0.58	0.39	0.56	0.53

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	2.21	2.56	2.68
Range	-	-	1.86 to 2.43	1.48 to 3.46	1.86 to 3.19
Stan. Deviation	-	-	0.31	0.77	0.57

K. Thin Film Oven Test, Kinematic Viscosity @ 275°F (Centistokes)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	345	317	487	681	493
Range	223 to 537	302 to 332	444 to 509	543 to 897	443 to 566
Stan. Deviation	168.3	21.2	37.0	118.1	50.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	6	3
Mean	-	-	495	662	490
Range	-	-	490 to 499	476 to 831	487 to 496
Stan. Deviation	-	-	6.4	134.3	4.9

L. Thin Film Oven Test, Penetration @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	86	73.5	47	46	53
Range	68 to 112	56 to 91	39 to 52	40 to 52	51 to 58
Stan. Deviation	23.1	24.7	7.0	4.6	2.7

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	50	49	56
Range	-	-	41 to 56.5	42 to 56	52 to 58
Stan. Deviation	-	-	7.9	5.6	2.7

M. Penetration @ 77°F Ratio
(After TFOT Penetration @ 77°F ÷ Original Penetration @ 77°F x 100)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	50.1	60.0	60.1	61.9	60.6
Range	41.2 to 57.1	59.6 to 60.3	57.5 to 62.9	54.5 to 69.0	59.3 to 62.7
Stan. Deviation	8.1	0.5	2.7	5.3	1.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	61.3	62.8	61.4
Range	-	-	54.3 to 66.5	55.7 to 70.8	56.5 to 66.5
Stan. Deviation	-	-	6.3	6.3	4.2

N. Specific Gravity @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	1.014	1.012	1.022	1.028	1.024
Range	1.000 to 1.025	1.007 to 1.017	1.019 to 1.026	1.024 to 1.033	1.020 to 1.027
Stan. Deviation	0.013	0.007	0.004	0.003	0.003

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	1.024	1.030	1.026
Range	-	-	1.022 to 1.027	1.025 to 1.033	1.023 to 1.028
Stan. Deviation	-	-	0.003	0.003	0.003

O. Flash Point, Cleveland Open Cup, °F

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	532	579	594	572	595
Range	442 to 600	578 to 580	557 to 615	480 to 665	564 to 625
Stan. Deviation	81.4	1.4	32.1	71.8	27.0

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	610	-	-
Range	-	-	590 to 625	460 to 550+	560 to 600+
Stan. Deviation	-	-	17.9	-	-

P. Ductility @ 39.2°F, 1cm/min., Original Sample (Centimeters)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	96.2	79.4	19.8	27.6	13.9
Range	17.50 to 150.0+	8.75 to 150.0+	7.50 to 38.0	8.25 to 84.0	10.75 to 18.50
Stan. Deviation	69.7	99.9	16.1	29.3	3.2

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	2	1	4
Mean	-	-	-	-	-
Range	-	-	15.0+	-	9.0 to 25.0+
Stan. Deviation	-	-	-	-	-

Q. Ductility @ 77°F, 5 cm/min., Original Sample (Centimeters)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	136.1	150.0+	150.0+	150.0+	150.0+
Range	108.25 to 150.0+	150.0+	150.0+	150.0+	150.0+
Stan. Deviation	24.1	-	-	-	-

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	4	3
Mean	-	-	-	-	-
Range	-	-	140.0+ to 150.0+	120.0+ to 150.0+	140.0+ to 150.0+
Stan Deviation	-	-	-	-	-

R. Solubility in Trichloroethylene, (%)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	99.95	99.64	99.81	99.95	99.86
Range	99.90 to 99.98	99.36 to 99.91	99.54 to 99.98	99.86 to 99.99	99.66 to 99.94
Stan. Deviation	0.04	0.39	0.23	0.04	0.12

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	2	6	4
Mean	-	-	99.80	99.95	99.87
Range	-	-	99.75 to 99.84	99.89 to 99.99	99.75 to 99.99
Stan. Deviation	-	-	0.06	0.04	0.11

S. Softening Point, Ethylene Glycol, (°F)

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	110	113	120	123	119
Range	105 to 115	108 to 118	118 to 124	120 to 125	117 to 120
Stan. Deviation	5.0	7.1	3.5	1.7	1.3

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	3	3
Mean	-	-	117	119	117
Range	-	-	111 to 123	105 to 126	116 to 119
Stan. Deviation	-	-	8.5	12.1	1.7

T. Penetration Viscosity Number, (PVN)

The penetration viscosity number, PVN, is an indicator of the temperature susceptibility of asphalt cements. Lower PVN indicates greater temperature susceptibility. It is suggested that an asphalt cement with a PVN less than -0.5 is temperature susceptible.

$$PVN = \frac{\text{Log A} - \text{Log V}}{\text{Log A} - \text{Log B}} \times (-1.5)$$

Where Log A = 4.25800 - 0.79674 Log (Penetration @ 77°F)
Log B = 3.46289 - 0.61094 Log (Penetration @ 77°F)
Log V = Log (Viscosity @ 275°F, Kinematic)

The results indiate that most of these asphalt cements are temperature susceptible by PVN criteria.

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	-0.617	-0.859	-0.717	-0.429	-0.639
Range	-0.161 to -1.177	-0.608 to -1.109	-0.599 to -0.928	-0.013 to -0.791	-0.556 to -0.794
Stan. Deviation	0.516	0.354	0.183	0.300	0.096

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	1	3	6	4
Mean	-	-	-0.714	-0.404	-0.605
Range	-	-	-0.543 to -0.949	+0.021 to -0.784	-0.554 to -0.661
Stan. Deviation	-	-	0.210	0.322	0.058

U. Penetration Index Numbers, (PIN)

The penetration Index Number is another indicator of temperature susceptibility of asphalt cements. Large negative values of PIN indicate greater temperature susceptibility. "Typical" asphalts have values between +2 and -2.

$$PIN = \frac{30}{1 + 90\ PTS} - 10$$

PTS = Penetration Temperature Susceptibility

$$PTS = \frac{\text{Log 800 - Log (Penetration @ 77°F)}}{\text{Softening Point (°F) - 77°F}}$$

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	+0.464	-0.233	-0.382	-0.109	-0.238
Range	+0.124 to +0.1022	-0.136 to -0.330	-0.370 to -0.406	+0.291 to -0.687	-0.071 to -0.464
Stan. Deviation	0.487	0.137	0.021	0.367	0.173

2. Comparative Results

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	1	0	2	3	3
Mean	-	-	-0.879	-0.741	-0.323
Range	-	-	-0.424 to -1.334	+0.349 to -2.564	+0.123 to -0.562
Stan. Deviation	-	-	0.643	1.589	0.386

V. A Settling Test to Evaluate The Relative Degree of Dispersion of Asphaltenes

by

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The asphaltene settling test is used to evaluate the relative degree of dispersion of asphaltenes from paving asphalts. This test distinguishes differences in asphaltene settling times of asphalts in their hexane-maltene solutions. The test involves digesting asphalt in n-hexane, transferring the contents into a graduated cylinder and measuring the time required for the asphaltene meniscus to settle to the 25 ml. mark of a 50 ml. cylinder. Slower settling times indicate a greater degree of dispersion of the asphaltenes and thus a more compatible asphalt, which in turn is considered to be an important property that contributes to asphalt durability. The test is extremely sensitive to changes in asphalt composition. Time is reported in minutes.

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	52.9	65.9	44.4	30.9	48.4
Range	27.8 to 92.8	32.1 to 99.7	30.7 to 66.3	17.3 to 52.7	26.9 to 93.5
Stan. Deviation	34.9	47.8	19.2	11.0	26.3

W. Asphalt Composition Analysis, by Liquid Chromatographic Separation and Densimetric Characterization

(Proposed) 1983 Annual ASTM Standards, Section 4, Volume 04.03, pages 792 to 799.

The purpose is to separate the four generic fractions present in asphalt. These fractions are saturates, naphthene aromatics, polar aromatics, and asphaltenes. The relative amount of each fraction plays a role in determining the physical properties of the asphalt. These properties include viscosity, ductility, softening point and temperature susceptibility.

The procedure follows:

The percent asphaltene is determined by dispersing the asphalt in n-heptane and refluxing. The insolubles are the asphaltenes.

The remaining three fractions are determined by absorbing the deasphaltened n-heptane solution on a calcined alumina chromatography column and eluting (removing) each fraction with a different solvent. Saturates are eluted with n-heptane. Naphthene aromatics are eluted with toluene. Polar Aromatics are eluted with 50/50 toluene - methanol solution, followed by trichloroethylene. The solvents are then evaporated and weight precentages of each fraction with respect to the original asphalt sample are determined.

Asphaltenes, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	13.1	12.4	12.3	15.9	14.9
Range	11.0 to 17.0	10.7 to 14.0	11.6 to 13.1	12.5 to 18.5	11.2 to 17.0
Stan. Deviation	3.4	2.3	0.8	2.2	2.4

Saturates, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	12.8	16.2	10.1	10.2	11.4
Range	9.0 to 18.0	14.0 to 18.4	8.8 to 11.6	7.8 to 14.6	9.6 to 12.2
Stan. Deviation	4.6	3.1	1.4	2.2	1.1

Naphthene - Aromatics, %

1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	29.4	29.3	28.8	27.6	29.3
Range	27.5 to 30.8	29.1 to 29.5	26.8 to 30.0	21.6 to 29.9	27.7 to 32.5
Stan. Deviation	1.7	0.3	1.7	2.8	1.9

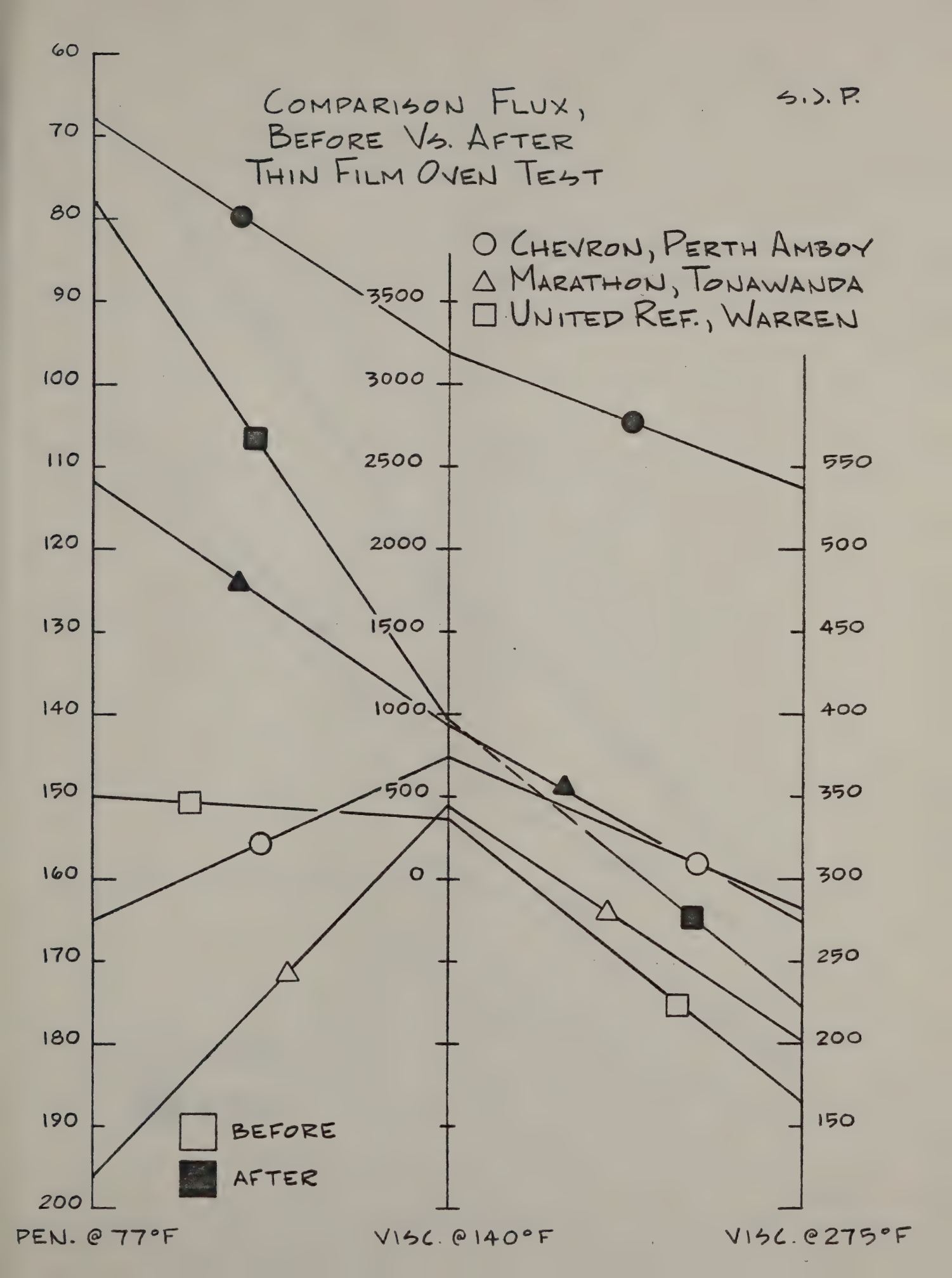
Polar Aromatics, %

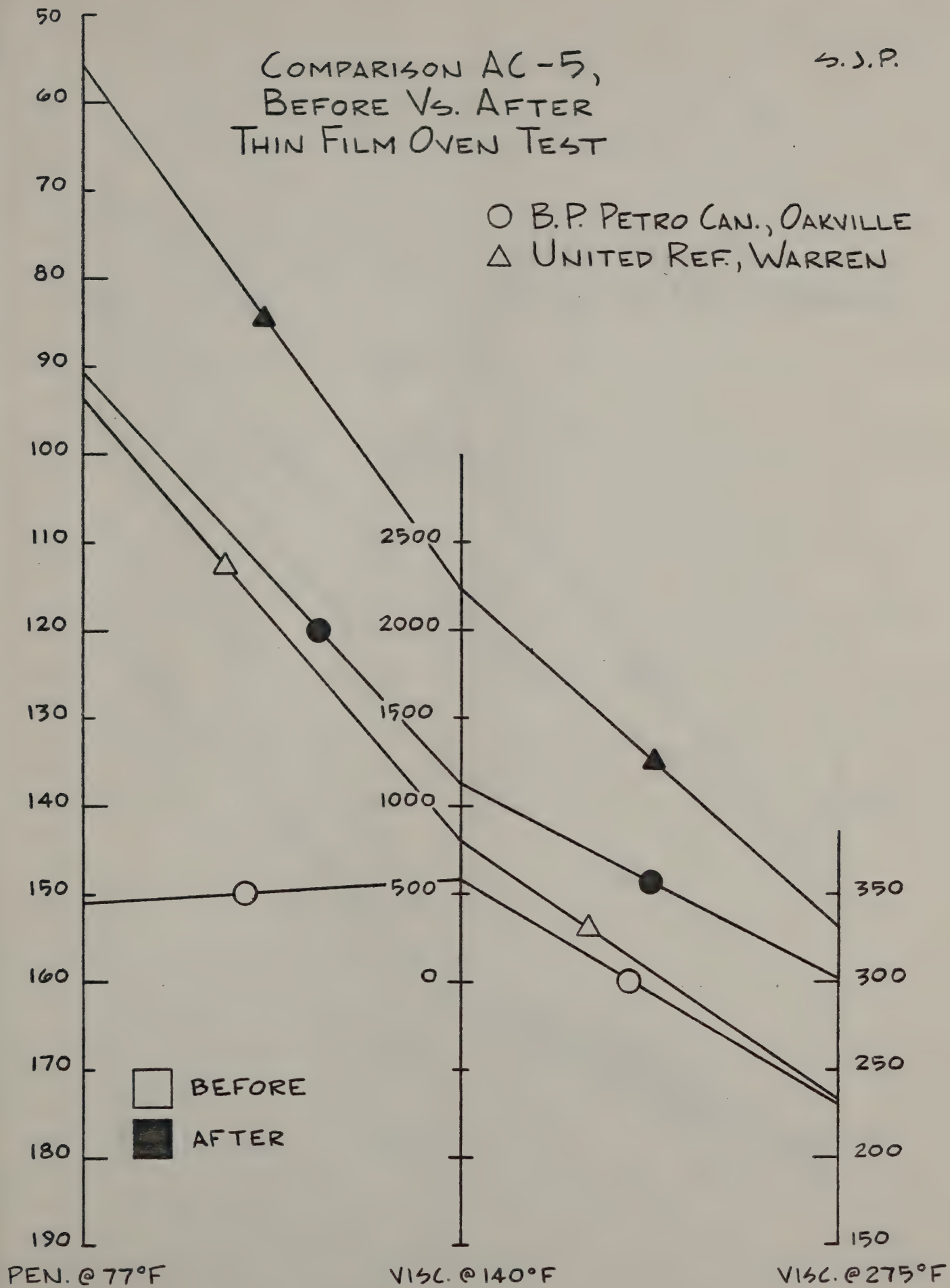
1. Materials Bureau

	FLUX	AC-5	AC-15	AC-20	85/100
No. of Samples	3	2	3	8	5
Mean	38.2	38.6	42.6	39.9	38.5
Range	33.9 to 42.5	35.9 to 41.3	40.2 to 45.1	33.3 to 44.2	36.0 to 44.3
Stan. Deviation	4.3	3.8	2.5	3.4	3.5

IX. Graphs and Charts of Related Materials Information

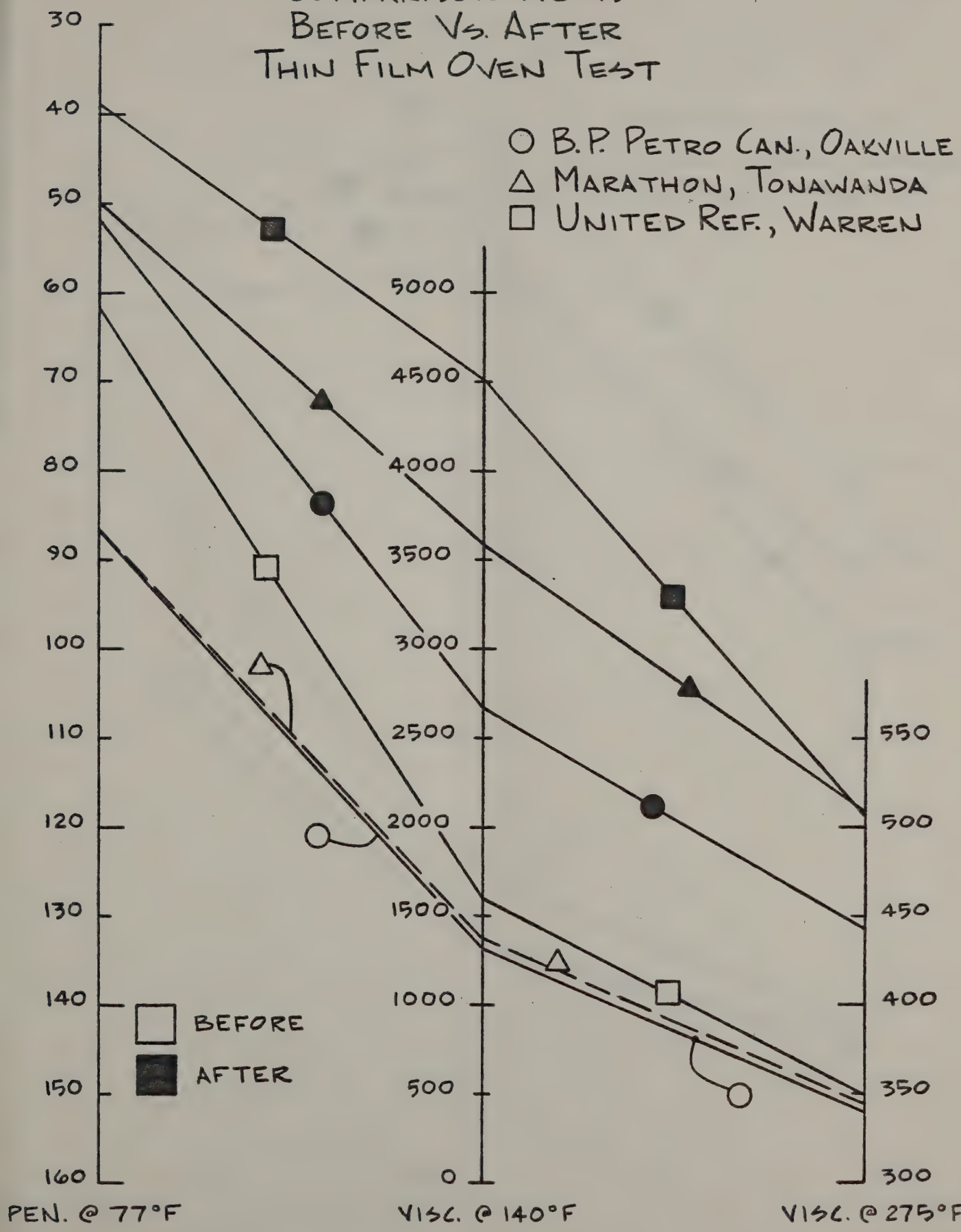
On the following pages are found a series of graphs and charts providing a comparison of Thin Film Oven Test Before and After, and charts showing Asphaltene Dispersion Settling Test.


COMPARISON FLUX,
BEFORE VS. AFTER
THIN FILM OVEN TEST
S.J.P.
○ CHEVRON, PERTH AMBOY
△ MARATHON, TONAWANDA
□ UNITED REF., WARREN
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
3500
3000
2500
2000
1500
1000
500
0
550
500
450
400
350
300
250
200
150
BEFORE
AFTER
PEN. @ 77°F
VISC. @ 140°F
VISC. @ 275°F


COMPARISON AC-5,
BEFORE VS. AFTER
THIN FILM OVEN TEST
S.J.P.
○ B.P. PETRO CAN., OAKVILLE
△ UNITED REF., WARREN
BEFORE
AFTER
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
2500
2000
1500
1000
500
0
350
300
250
200
150
PEN. @ 77°F
VISC. @ 140°F
VISC. @ 275°F

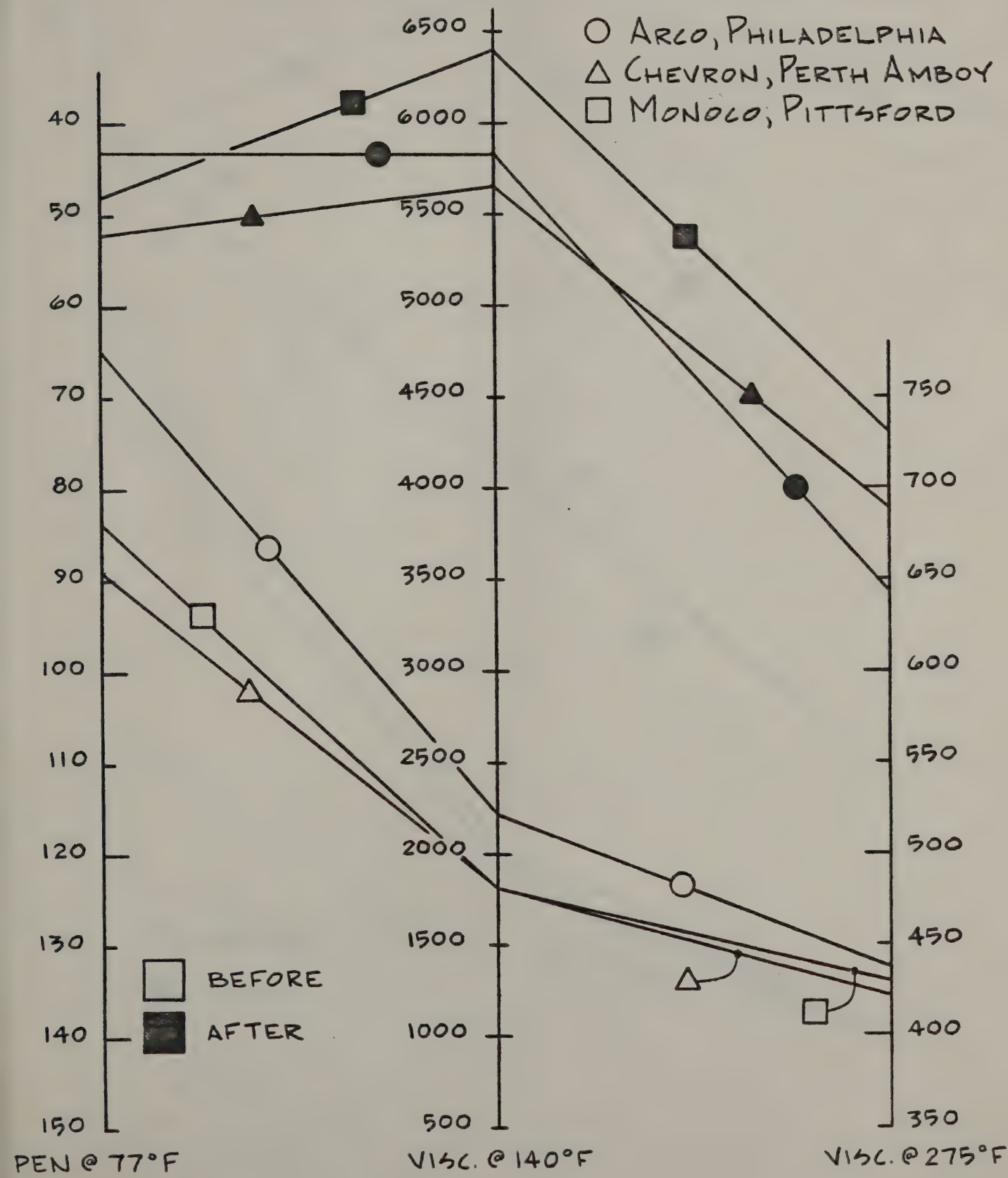
Comparison AC-15
Before Vs. After
Thin Film Oven Test

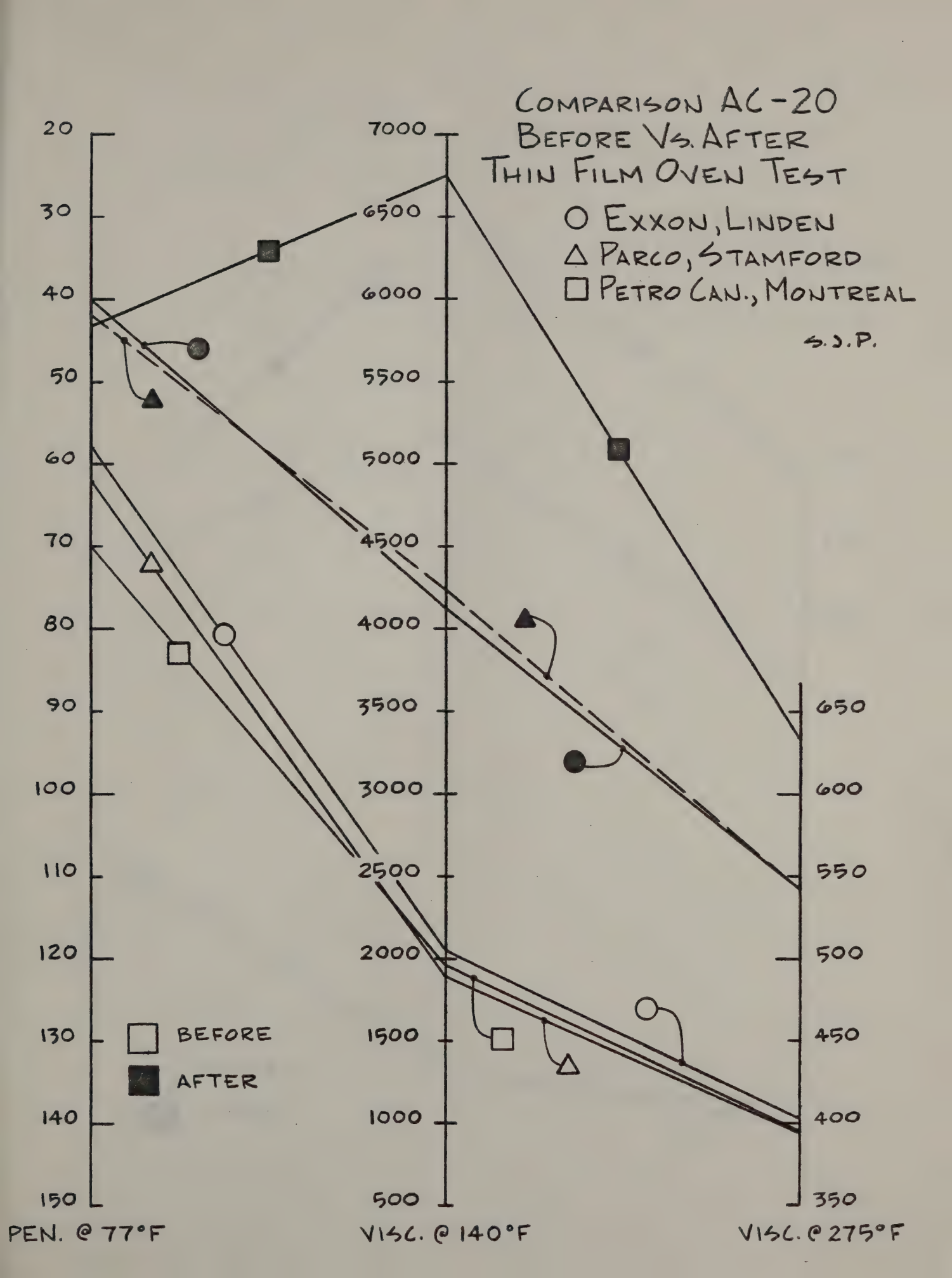
S.J.P.

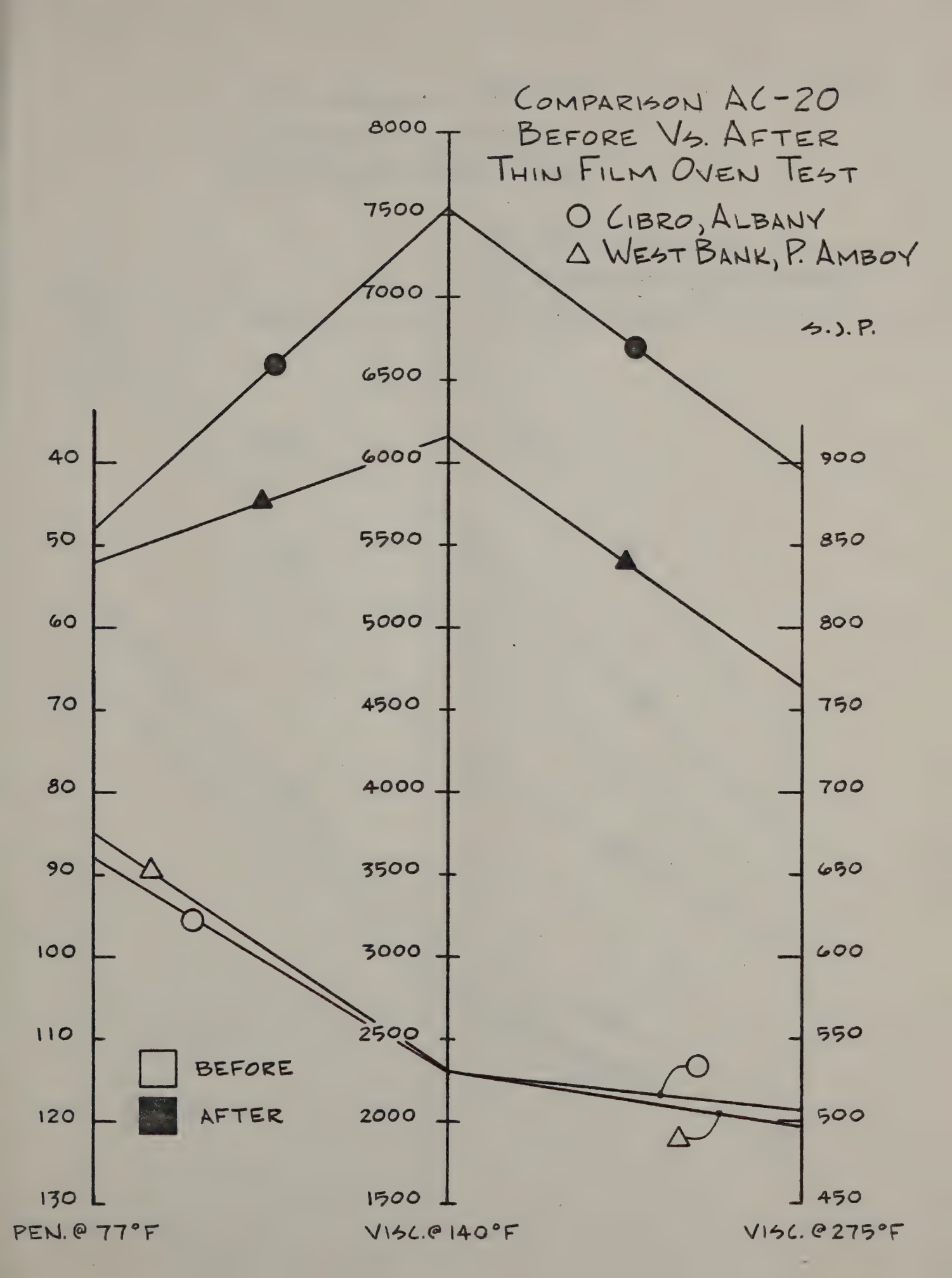


Comparison AC-20
Before Vs. After
Thin Film Oven Test

S.J.P.

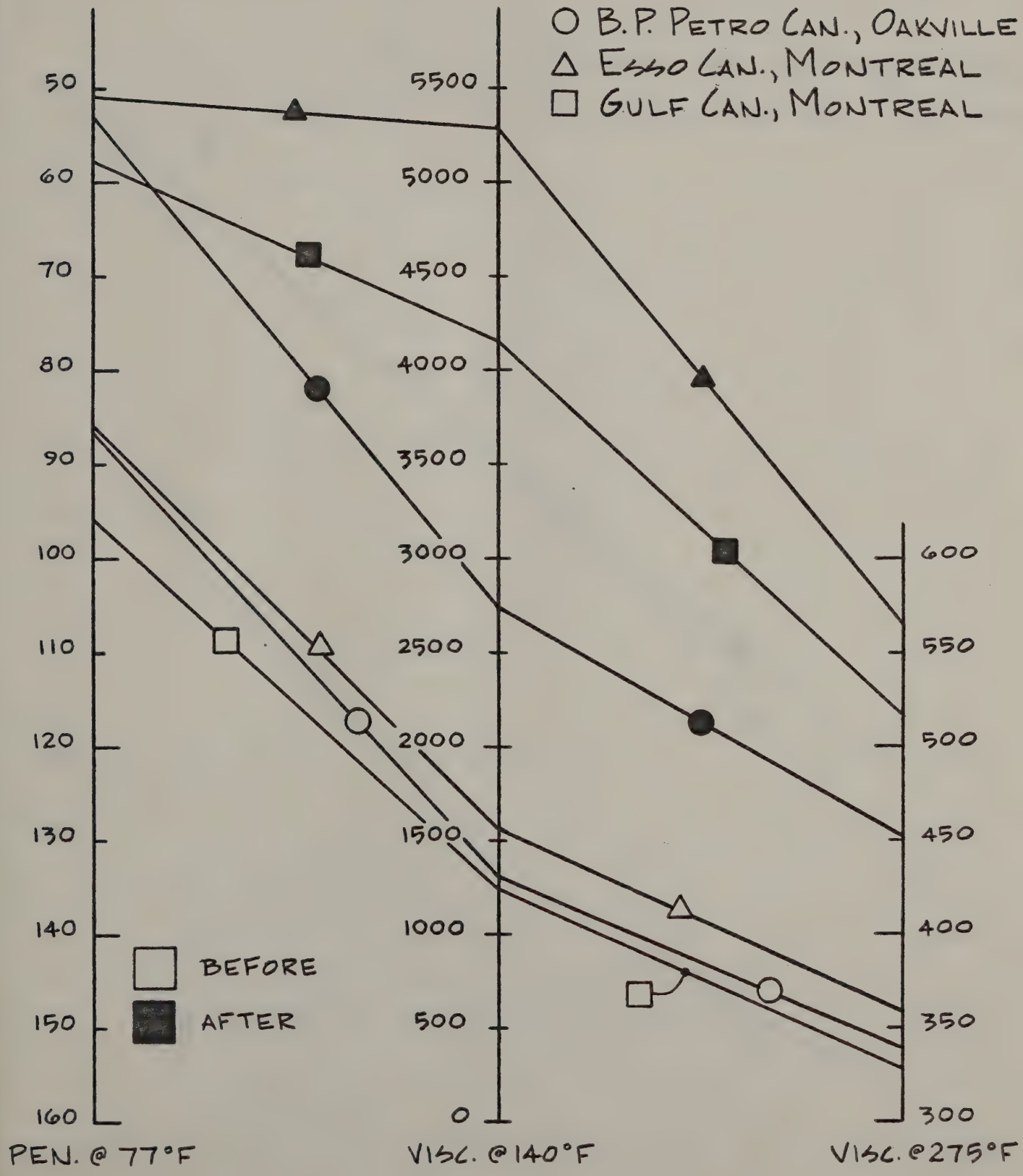



COMPARISON AC-20
BEFORE VS. AFTER
THIN FILM OVEN TEST
O EXXON, LINDEN
△ PARCO, STAMFORD
□ PETRO CAN., MONTREAL
S.J.P.
20
30
40
50
60
70
80
90
100
110
120
130
140
150
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
650
600
550
500
450
400
350
BEFORE
AFTER
PEN. @ 77°F
VISC. @ 140°F
VISC. @ 275°F


COMPARISON AC-20
BEFORE VS. AFTER
THIN FILM OVEN TEST
O CIBRO, ALBANY
△ WEST BANK, P. AMBOY
S.S.P.
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
40
50
60
70
80
90
100
110
120
130
900
850
800
750
700
650
600
550
500
450
BEFORE
AFTER
PEN. @ 77°F
VISC. @ 140°F
VISC. @ 275°F

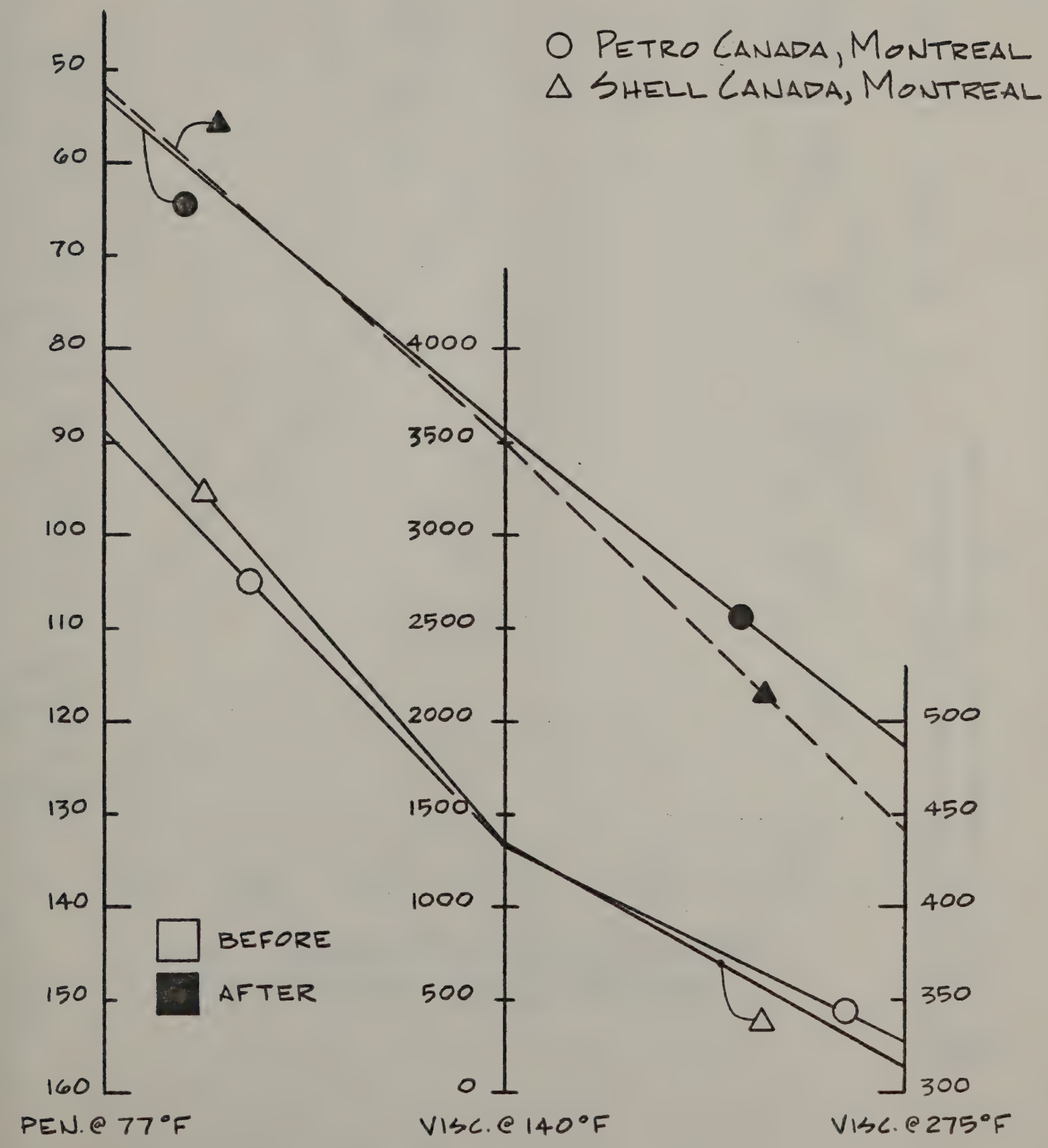
Comparison 85/100
Before Vs. After
Thin Film Oven Test

S.J.P.

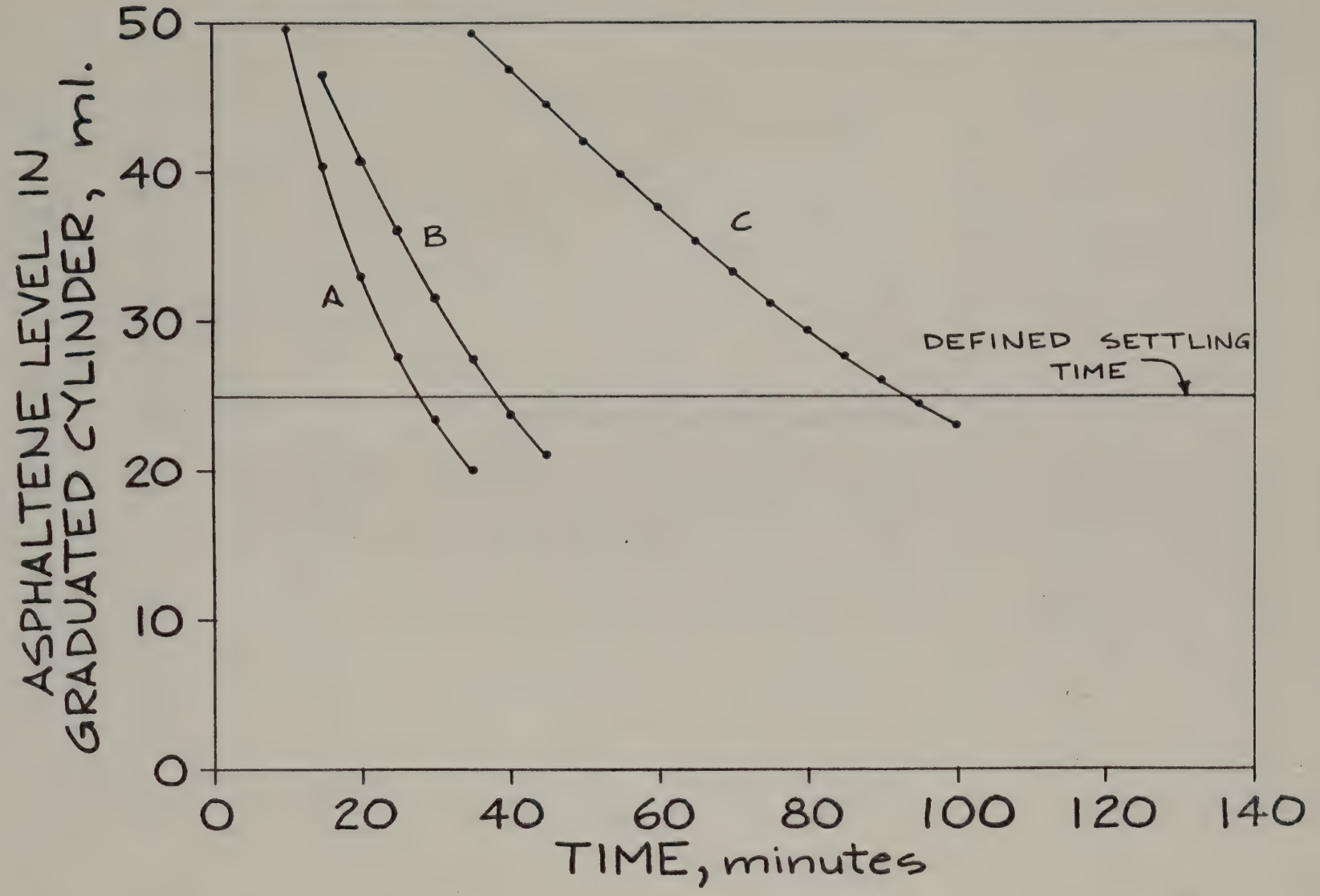


S.S.P.

Comparison 85/100
Before Vs. After
Thin Film Oven Test



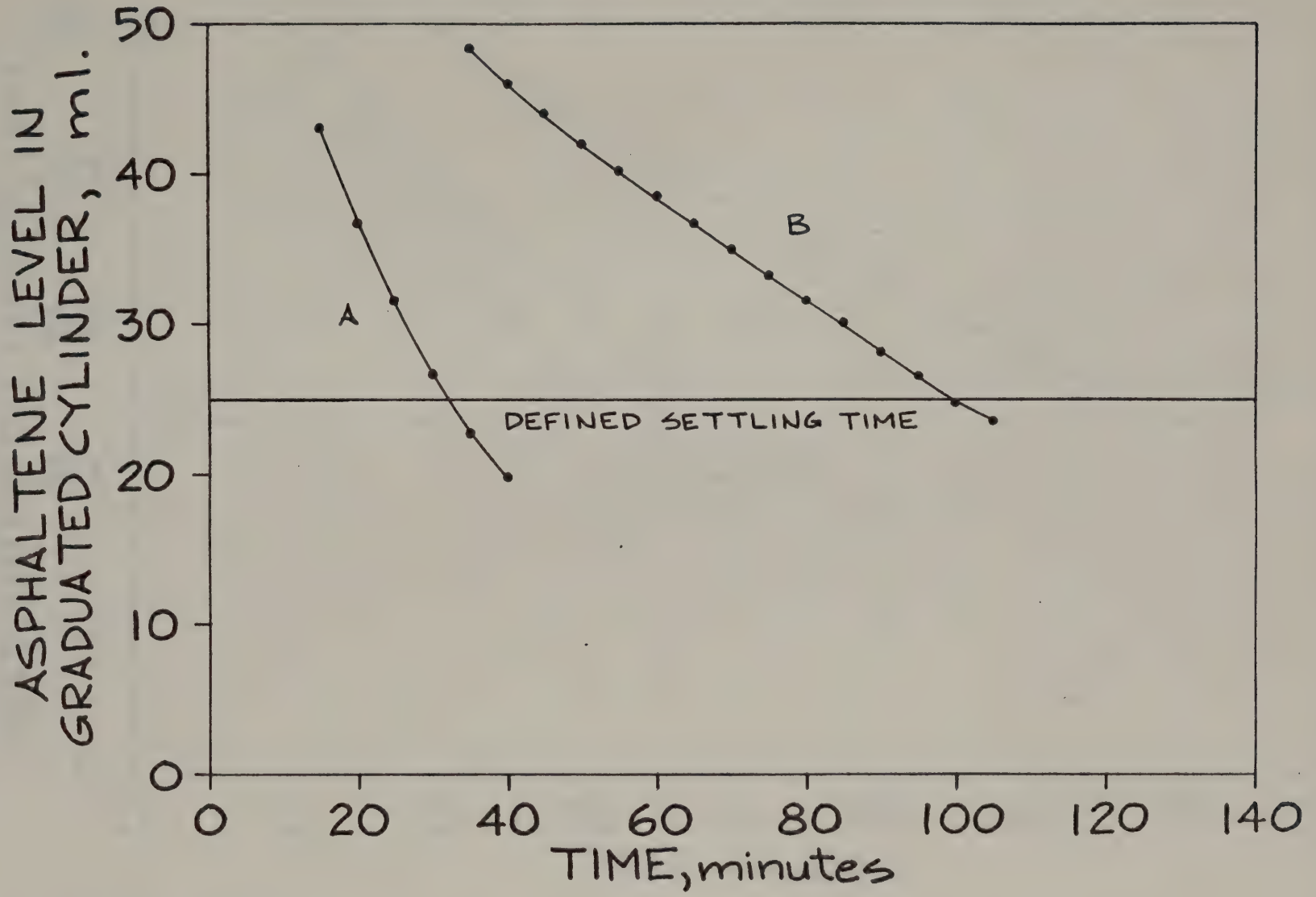
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = Flux, Chevron, Perth Amboy
B = Flux, Marathon, Tonawanda
C = Flux, United Ref., Warren

S. J. P.

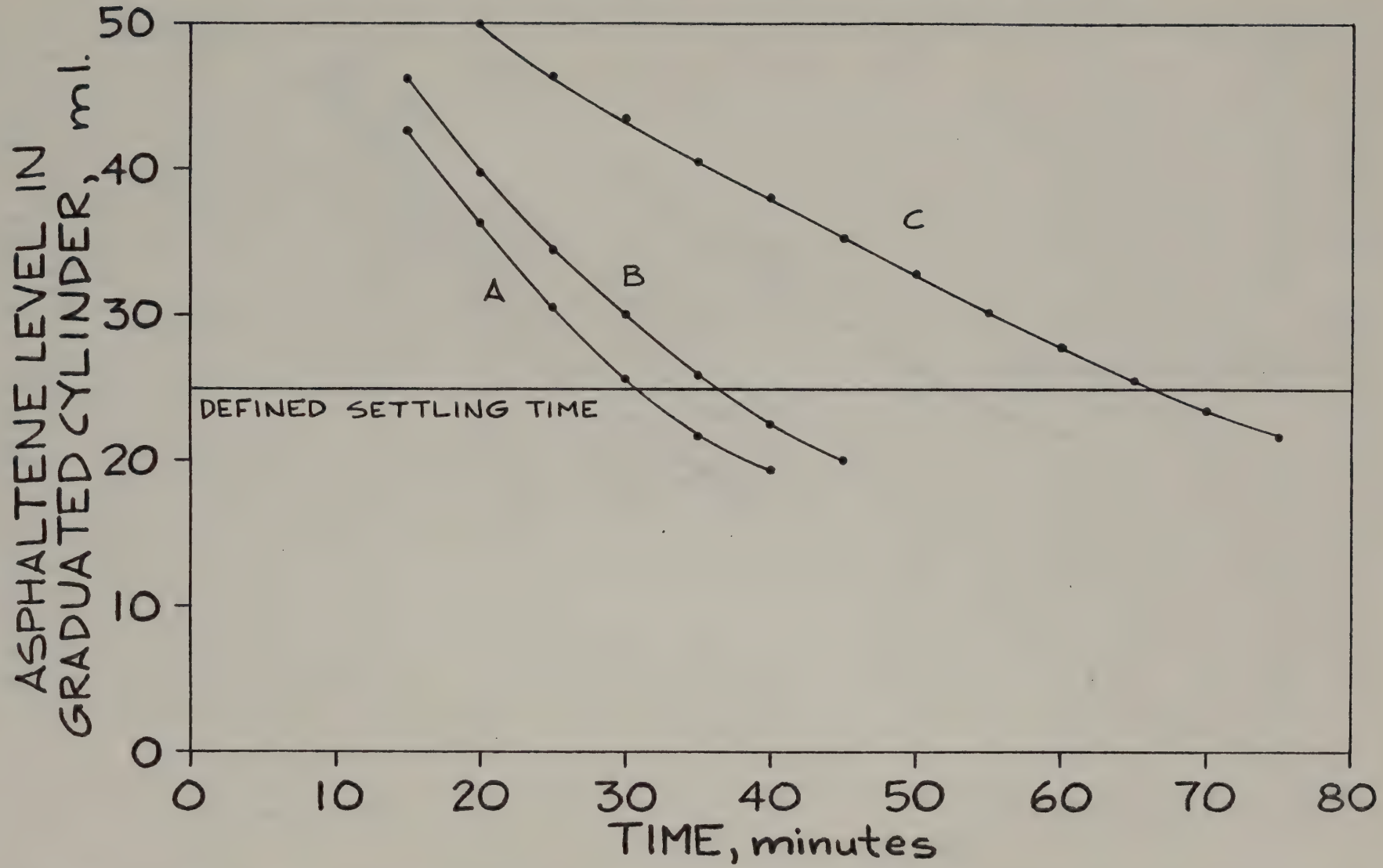
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-5, B.P. PETRO CANADA, OAKVILLE
B = AC-5, UNITED REF., WARREN, PA.

S.J.P.

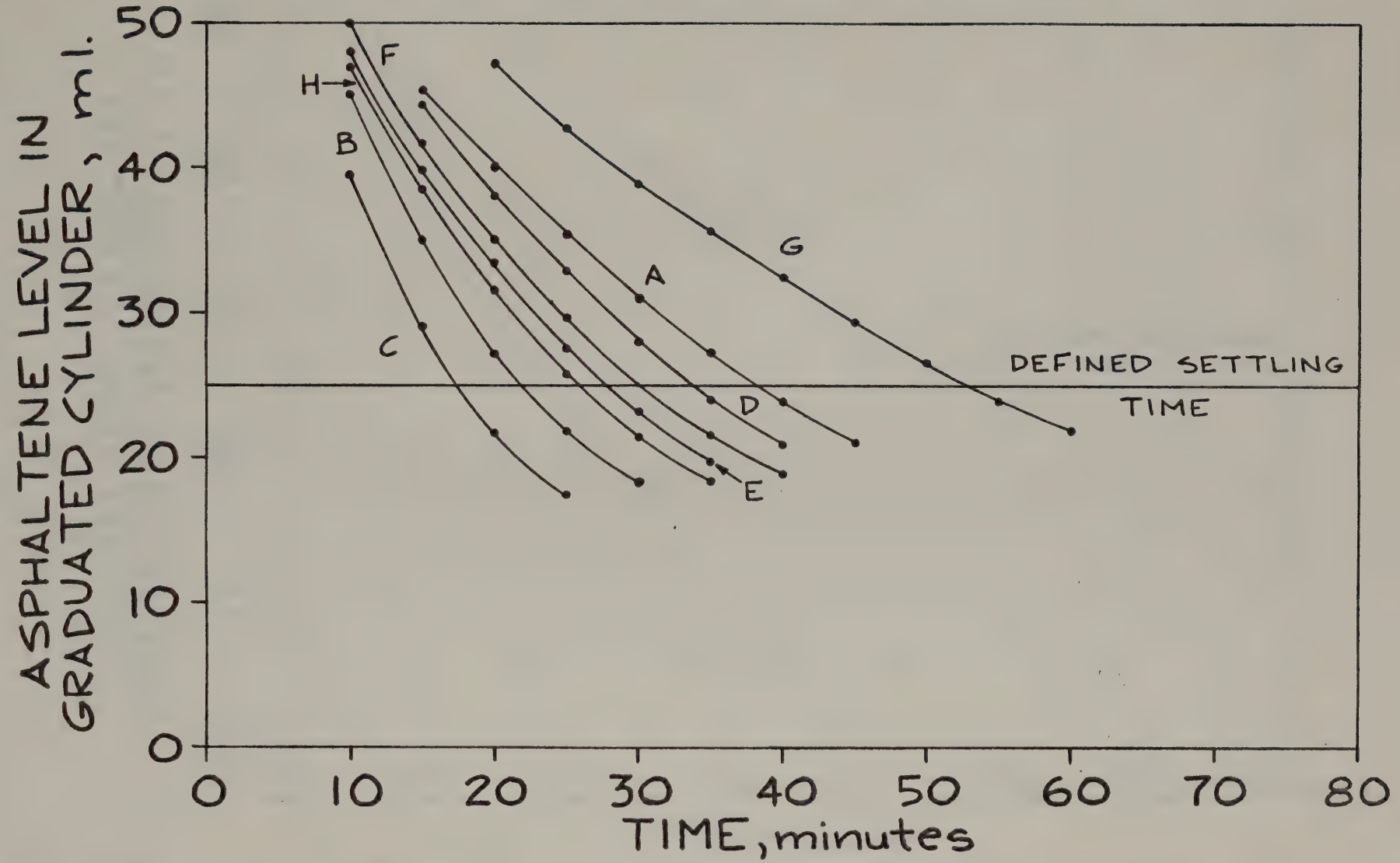
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-15, B.P. PETRO CAN., OAKVILLE, ONT.
B = AC-15, MARATHON, TONAWANDA
C = AC-15, UNITED REF., WARREN, PA.

S.J.P.

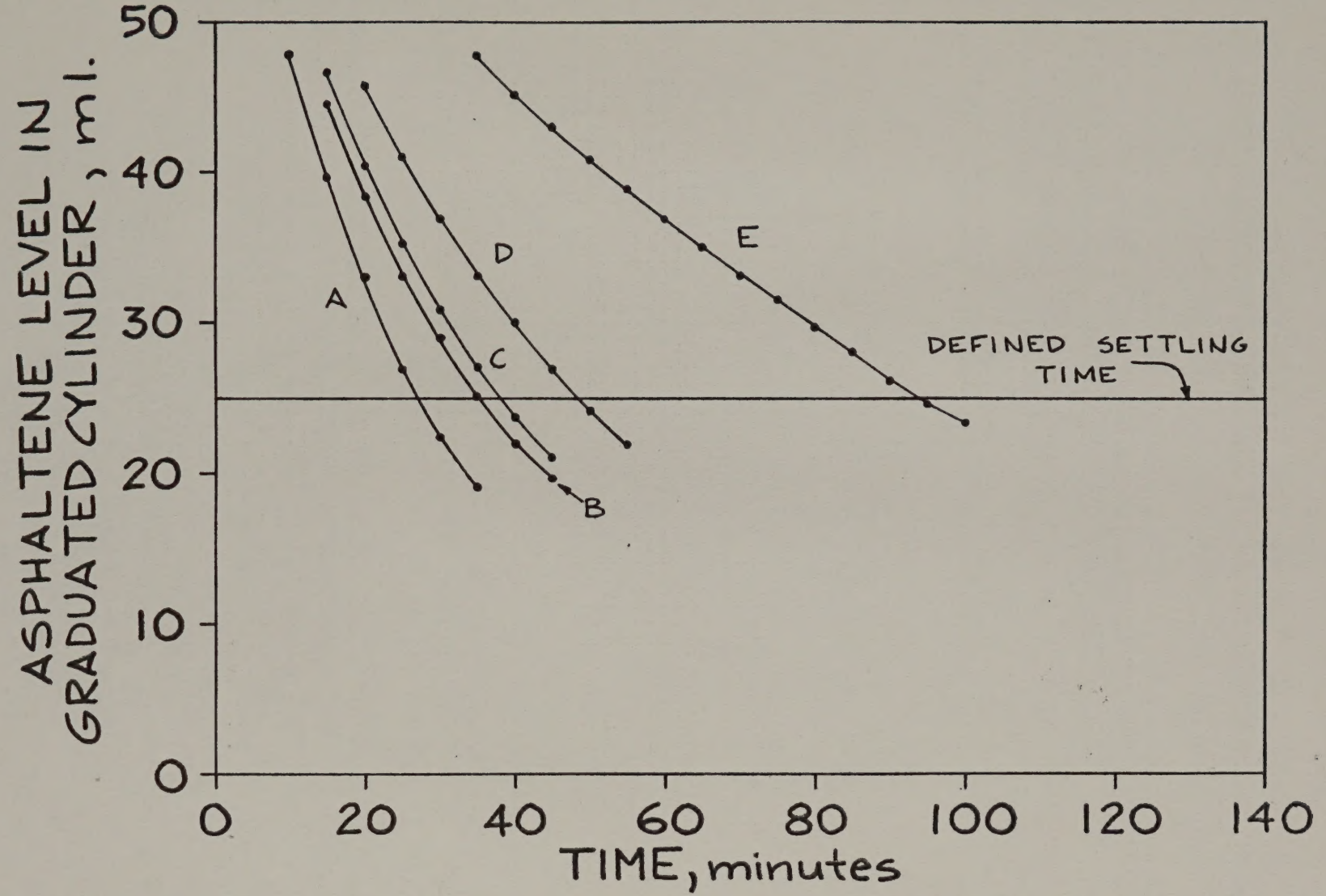
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-20, ARCO, PHILADELPHIA
B = AC-20, CHEVRON, P. AMBOY
C = AC-20, CIBRO, ALBANY
D = AC-20, EXXON, LINDEN
E = AC-20, MONOCO, PITTSFORD
F = AC-20, PARCO, STAMFORD
G = AC-20, PETRO CAN., MONTREAL
H = AC-20, WEST BANK, P. AMBOY

S.J.P.

A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = 85/100, B.P. Petro Can., Oakville
B = 85/100, Esso Can., Montreal
C = 85/100, Gulf Can., Montreal
D = 85/100, Petro Can., Montreal
E = 85/100, Shell Can., Montreal

S.J.P.

0
20
40
60
80
100
120
140
TIME, minutes
0
10
20
30
40
50
GRADUATED CYLINDER, ml.
ASPHALTENE LEVEL IN
DEPRESSION TO
SETTLING
A
B
C
D
E

01542
LRI